

START

0036122

MAR 1988

NPL CANDIDATE

P.D. STENNIS

Update #

Received

SEP 14 1987

Facility name: U.S. DOE Hanford 200 AreaLocation: Hanford SiteEPA Region: XPerson(s) in charge of the facility: J. J. Keating, Asst. Mgr.Safety, Environment and Security509 - 376 - 7334Name of Reviewer: D. M. Bennett, EPA Region XDate: 8/18/87

General description of the facility:

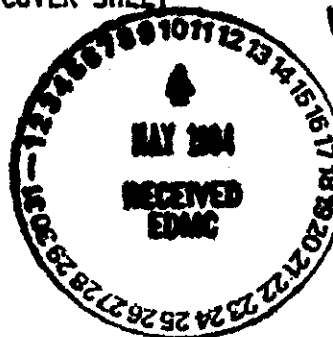
(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

The 200 Area site contains the 216-A-1, 216-A-2, 216-A-4, 216-A-5,216-A-6, 216-A-7, 216-A-9, 216-A-11, 216-A-12, 216-A-13, 216-A-14,216-A-15, 216-A-16, 216-A-17, 216-A-18, 216-A-19, 216-A-20, 216-A-21,216-A-22, 216-A-23A, 216-A-23B, 216-A-24, 216-A-26A, 216-A-27,216-A-28, 216-A-31, 216-A-32, 216-A-33, 216-A-34, 216-A-35, 216-A-36A,216-A-39, 216-A-40, 216-A-41, 216-B-2-1, 216-B-2-2, 216-B-3-1,216-B-3-2, 216-B-4, 216-B-5, 216-B-6, 216-B-7A&B, 216-B-8, 216-B-9,Scores: SM = 69.05 (S_{gw} = 79.59 S_{sw} = 89.09 S_a = 0.00)

SFE = 0.00

SDC = 0.00

FIGURE 1
HRS COVER SHEET



QA

1/2/88

Kathleen D. Albany

National Priorities List

Superfund hazardous waste site listed under the
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended in 1986

HANFORD 200-AREA (USDOE)
Benton County, Washington

The Hanford 200-Area is in the middle of the 570-square-mile-Hanford Site approximately 20 miles north of the City of Richland, Benton County, Washington. Since 1943, Hanford has been the scene of Federal nuclear activities, primarily production of nuclear materials for national defense.

The U.S. Department of Energy (USDOE) uses the 200-Area for nuclear fuel reprocessing, finishing, and waste management. Over 230 waste disposal locations have been identified in the 200-Area. The disposal locations and plumes of contaminated ground water cover approximately 215 square miles.

An estimated 1 billion cubic yards of solid and dilute liquid wastes comprised of radioactive, mixed and hazardous constituents were disposed of in trenches, ditches, and landfills in the 200-Area. USDOE has detected tritium, iodine-129, uranium, cyanide, and carbon tetrachloride at levels significantly above background in ground water beneath the area. Over 2,500 people obtain drinking water from wells within 3 miles of the 200-Area. Tritium has been detected in Richland's surface water intakes at levels above background. Surface water within 3 miles of the 200-Area provides drinking water to 70,000 people and irrigates over 1,000 acres.

EPA, USDOE, and the Washington Department of Ecology are jointly developing an action plan that will include the work needed to address this area under the Superfund program, as well as other work needed to meet permitting, corrective action, and compliance requirements of Subtitle C of the Resource Conservation and Recovery Act.

NPL CANDIDATE

Update # _____

Received: _____

SEP 14 1987

Facility name: U.S. DOE Hanford 200 Area

Location: Hanford Site

EPA Region: X

Person(s) in charge of the facility: J. J. Keating, Asst. Mgr.

Safety, Environment and Security

509 - 376 - 7334

Name of Reviewer: D. M. Bennett, EPA Region X

Date: 8/18/87

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

The 200 Area site contains the 216-A-1, 216-A-2, 216-A-4, 216-A-5,
216-A-6, 216-A-7, 216-A-9, 216-A-11, 216-A-12, 216-A-13, 216-A-14,
216-A-15, 216-A-16, 216-A-17, 216-A-18, 216-A-19, 216-A-20, 216-A-21,
216-A-22, 216-A-23A, 216-A-23B, 216-A-24, 216-A-26A, 216-A-27,
216-A-28, 216-A-31, 216-A-32, 216-A-33, 216-A-34, 216-A-35, 216-A-36A,
216-A-39, 216-A-40, 216-A-41, 216-B-2-1, 216-B-2-2, 216-B-3-1,
216-B-3-2, 216-B-4, 216-B-5, 216-B-6, 216-B-7A&B, 216-B-8, 216-B-9,

Scores: SM = 69.05 (S_{gw} = 79.59 S_{sw} = 89.09 S_a = 0.00)

SFE = 0.00

SDC = 0.00

FIGURE 1
HRS COVER SHEET

QA
1/2/88
Kathleen G. Halley

94328.027

216-B-10A, 216-B-10B, 216-B-11A&B, 216-B-12, 216-B-13, 216-B-14,
216-B-15, 216-B-16, 216-B-17, 216-B-18, 216-B-19, 216-B-20, 216-B-21,
216-B-22, 216-B-23, 216-B-24, 216-B-25, 216-B-26, 216-B-27, 216-B-28,
216-B-29, 216-B-30, 216-B-31, 216-B-31, 216-B-32, 216-B-33, 216-B-34,
216-B-35, 216-B-36, 216-B-37, 216-B-38, 216-B-40, 216-B-41, 216-B-42,
216-B-43, 216-B-44, 216-B-45, 216-B-46, 216-B-47, 216-B-48, 216-B-49,
216-B-50, 216-B-51, 216-B-52, 216-B-53A, 216-B-53B, 216-B-54, 216-B-57
216-B-58, 216-B-60, 216-C-1, 216-C-3, 216-C-4, 216-C-5, 216-C-6,
216-C-8, 216-C-10, 218-E-1, 218-E-2, 218-E-2A, 218-E-3, 218-E-4,
218-E-5, 218-E-5A, 218-E-6, 218-E-7, 218-E-8, 218-E-9, 218-E-12A,
218-E-13, 218-E-14, 200 East Burning Pit, 200 East Construction Pit,
216-N-1, 216-N-2, 216-N-3, 216-N-4, 216-N-5, 216-N-6, 216-N-7,
216-S-1&2, 216-S-3, 216-S-4, 216-S-5, 216-S-6, 216-S-7, 216-S-8,
216-S-9, 216-S-11, 216-S-12, 216-S-13, 216-S-14, 216-S-15, 216-S-16P,
216-S-16D, 216-S-17, 216-S-18, 216-S-20, 216-S-21, 216-S-22, 216-S-23,
216-T-2, 216-T-3, 216-T-4-1(D), 216-T-4-1(P), 216-T-4-2(D), 216-T-5,
216-T-5, 216-T-6, 216-T-7, 216-T-8, 216-T-9, 216-T-10, 216-T-11,
216-T-12, 216-T-13, 216-T-14, 216-T-15, 216-T-16, 216-T-17, 216-T-18,
216-T-19, 216-T-20, 216-T-21, 216-T-22, 216-T-23, 216-T-24, 216-T-24,
216-T-25, 216-T-26, 216-T-27, 216-T-28, 216-T-29, 216-T-30, 216-T-31,
216-T-32, 216-T-33, 216-T-34, 216-T-35, 216-T-36, 216-U-1&2, 216-U-2,
216-U-3, 216-U-4, 216-U-4A, 216-U-4B, 216-U-5, 216-U-6, 216-U-7,
216-U-8, 216-U-9, 216-U-11, 216-U-13, 216-U-15, 216-U-15, 216-Z-1A,
216-Z-1(D), 216-Z-1&2, 216-Z-3, 216-Z-4, 216-Z-5, 216-Z-6, 216-Z-7,
216-Z-8, 216-Z-9, 216-Z-10, 216-Z-11, 216-Z-12, 216-Z-16, 216-Z-17,

FIGURE 1 (Continued)
HRS COVER SHEET

11/2/88
KJP

216-Z-18, 218-W-1, 218-W-1A, 218-W-2, 218-W-3, 218-W-4A, 218-W-7,
218-W-8, 218-W-9, 218-W-11, Non-Rad Burial Ground, 200-West Burning Pit
Z-Plant Burning Pit, 618-10, 618-11, P-11 Crib, 213 J and K Cribs,
J. A. Jones No. 1, Original Central Landfill. The above 600 numbered
sites were included in the 200 Area because they are located within the
defined boundaries of the 200 Area. The ground water and surface water
are the routes of major concern. The individual sites listed above are
either surface impoundments (i.e., trenches or ditches) or landfills
(i.e., land disposal). The 200 Area is located approximately 20 miles
north of the City of Richland.

FIGURE 1 (Continued)
HRS COVER SHEET

1/12/88
217

HRS Ground Water Route Work Sheet

Site: U.S. DOE Hanford 200 Area

8/18/87

Rating Factor	Assigned Value	Multiplier	Score	Max. Score	Ref. (Section)
1. Observed Release	45	1	45	45	3.1
If observed release is given a score of 45, proceed to line 4. If observed release is given a score of 0, proceed to line 2.					
2. Route Characteristics					3.2
Depth to Aquifer of Concern	0	2	0	6	
Net Precipitation	0	1	0	3	
Permeability of the Unsaturated Zone	0	1	0	3	
Physical State	0	1	0	3	
Total Route Characteristics Score			0	15	
3. Containment	0	1	0	3	3.3
4. Waste Characteristics					3.4
Chemical					
a. Toxicity/Persistence	18	1	18	18	
Hazardous Waste Quantity	8	1	8	8	
Total Waste Characteristics Score			26	26	
5. Targets					3.5
Ground Water Use	3	3	9	9	
Distance to Nearest Well/Population Served	30	1	30	40	
Total Targets Score			39	59	
6. If line 1=45 (1x4x5)					
If line 1=0 (2x3x4x5)			45630	57330	
7. Line 6/57330 * 100	Sc(gw)=	79.59			

11/12/88
 XCA

HRS Surface Water Route Work Sheet

Site: U.S. DOE Hanford 200 Area

8/18/87

Rating Factor	Assigned Value	Multiplier	Score	Max. Score	Ref. (Section)
1. Observed Release	45	1	45	45	4.1
If observed release is given a score of 45, proceed to line 4. If observed release is given a score of 0, proceed to line 2.					
2. Route Characteristics					4.2
Facility Slope & Intervening Terrain	0	1	0	3	
1-yr. 24-hr. Rainfall	0	1	0	3	
Distance to Nearest Surface Water	0	2	0	6	
Physical State	0	1	0	3	
Total Route Characteristics Score			0	15	
3. Containment	0	1	0	3	4.3
4. Waste Characteristics					4.4
a. Chemical					
Toxicity/Persistence	18	1	18	18	
Hazardous Waste Quantity	8	1	8	8	
Total Waste Characteristics Score			26	26	
5. Targets					4.5
Surface Water Use	3	3	9	9	
Distance to a Sensitive Environment	0	2	0	6	
Population Served/Distance to Water Intake Downstream	40	1	40	40	
Total Targets Score			49	55	
6. If line 1=45 (1x4x5) If line 1=0 (2x3x4x5)			57330	64350	
7. Line 6/64350 * 100	Sc(sw)=	89.09			

11/12/87
Kt2

HRS Air Route Work Sheet

ROUTE NOT SCORED

Rating Factor	Assigned Value	Multiplier	Score	Max. Score	Ref. (Section)
1. Observed Release	0	1	0	45	5.1

Date and Location:

Sampling Protocol:

If observed release is given a score of 45, proceed to line 2.
If observed release is given a score of 0, the Sa=0. Enter on Line 5.

2. Waste Characteristics 5.2

a. Chemical				
Reactivity and Incompatibility	0	1	0	3
Toxicity	0	3	0	9
Hazardous Waste Quantity	0	1	0	8

Total Waste Characteristics Score 0 20

3. Targets 5.3

Population Within 4-Mile Radius	0	1	0	30
Distance to Sensitive Environment	0	2	0	6
Land Use	0	1	0	3

Total Targets Score 0 39

4. Multiply 1 x 2 x 3 0 35100

5. Line 4/35100 * 100 Sc(a)= 0.00

11/2/88
K29

	S	S ²
Groundwater Route Score (S _{gw})	79.59	6334.57
Surface Water Route Score (S _{sw})	89.09	7937.03
Air Route Score (S _a)	0.00	0.00
$S_{gw}^2 + S_{sw}^2 + S_a^2$	-	14271.60
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$	-	119.46
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		69.05

FIGURE 10
WORKSHEET FOR COMPUTING S_M

11/12/88
KJG

DOCUMENTATION RECORDS
FOR
HAZARD RANKING SYSTEM

INSTRUMENTATIONS: As briefly as possible summarize the information you used to assign the score for each factor (e.g., "Waste quantity = 4,230 drums plus 800 cubic yards of sludge"). The source of information should be provided for each entry and should be a bibliographic-type reference, include the location of the document.

FACILITY NAME: U.S. DOE Hanford Site - 200 Area

LOCATION: Hanford Site, Benton County, Washington

DATE SCORED: August 18, 1987

PERSON SCORING: R. D. Stenner, Pacific Northwest Laboratory for DOE

PRIMARY SOURCE(S) OF INFORMATION (e.g., EPA region, state, FIT, etc.):

The information was taken from Department of Energy documents and databases associated with the Hanford site, as well as from other publicly available documents addressing conditions at or in the vicinity of the Hanford Site. Information was also gathered through telephone and personal communications with responsible individuals (such information is referenced accordingly in the package).

FACTORS NOT SCORED DUE TO INSUFFICIENT INFORMATION:

Even though air concentrations of some of the constituents of interest can be detected above background offsite, no air monitoring data was found sufficient for HRS scoring of the Hanford CERCLA sites. These constituents of interest detected above background offsite are present in the routine gaseous effluents from operating facilities at Hanford. Therefore, the air route rating factors were not scored.

COMMENTS OR QUALIFICATIONS:

The Department of Energy has completed a preliminary assessment of the hazardous waste sites located on the Hanford Site. This work served as the primary basis of developing the scores for the aggregate 200 Area Site. These preliminary assessment efforts are documents in the "Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford" volumes and respective addenda which are referenced throughout this package.

QA
11/12/88
Kathleen E. Galloway

GROUND WATER ROUTE

1 OBSERVED RELEASE

Contaminants detected (5 maximum):

An observed release to the ground water from the 200 Area can be verified using several selected constituents. For the purpose of documenting observed release from the 200 Areas, five substances have been selected. These substances are tritium (H-3), iodine-129 (I-129), uranium (U), cyanide (CN-) and carbon tetrachloride (CCl₄). The Hanford Ground Water Data Base lists carbon tetrachloride as tetrane. Five substances were selected for evidence of observed release due to the variety of chemical processes utilized within the 200 Area. Tritium and I-129 are included as indicators of maximum areal extent of contamination while uranium, cyanide and carbon tetrachloride are included to identify isolated contaminant plumes associated with individual processes. Comparison of background and down gradient concentrations can be illustrated for each of the constituents selected. The following tables present the data for each of the constituents and their background and down gradient concentrations.

200 Area Concentrations for Tritium

BACKGROUND			DOWN GRADIENT		
Date	Well	Concentration (pCi/L)	Date	Well	Concentration (pCi/L)
2/4/86	6-25-55	-320(a)	3/13/86	6-35-70	1,600,000
			2/4/86	6-37-43	22,000
			3/5/84	481 Bldg Tap	35,400

(a) The negative value means that the concentration is less than detection limit.

200 Area Concentrations for Iodine-129

BACKGROUND			DOWN GRADIENT		
Date	Well	Concentration (pCi/L)	Date	Well	Concentration (pCi/L)
5/29/86	6-25-55	0.000094	6/6/86	699-32-22	4.89

1/12/88
KEA

200 Area Concentrations for Uranium

BACKGROUND			DOWN GRADIENT		
Date	Well	Concentration (pCi/L)	Date	Well	Concentration (pCi/L)
2/3/87	6-55-89	1.06	3/11/87	2-W19-3	14,900
			7/22/87	2-W19-9	2748

200 Area Concentrations for Cyanide

BACKGROUND			DOWN GRADIENT		
Date	Well	Concentration (μ g/L)	Date	Well	Concentration (μ g/L)
3/25/87	6-51-75	< 10	3/19/87	6-50-53	405

200 Area Concentrations for Carbon Tetrachloride

BACKGROUND			DOWN GRADIENT		
Date	Well	Concentration (μ g/L)	Date	Well	Concentration (μ g/L)
3/25/87	6-51-75	< 10	3/16/87	2-w10-4	2000
2/4/87	6-25-55	< 10			

Additional well locations have been identified that contain these constituents, but further evidence of observed release is unnecessary.

Reference 2, page 3.14; Reference 7, pages 92, 144, 220, 229, 232, 238, 248, 252, 254, 259; Reference 8, 481 Bldg Tap Water Sample Report; Reference 22; Reference 23; Reference 24; Reference 25; Reference 26; Reference 27

Rationale for attributing the contaminants to the facility:

The rationale for attributing the five substances to the 200 Area requires a brief discussion of each constituent. Tritium and Iodine-129 are fission products that are released as a result of irradiated fuel reprocessing. Both of these constituents are highly mobile in the Hanford environment and are used as indicators of extent of contamination. Localized uranium contamination in the 200 Area is due to the uranium recovery operation performed at U-Plant. Use of ferrocyanide, a complex cyanide compound, to precipitate cesium during uranium recovery operations has also been documented. Carbon tetrachloride was used in a solvent extraction process in the plutonium finishing plant. Spent solvent from the process was subsequently disposed of into adjacent facilities. The concentrations shown in the above tables for down gradient wells are significantly higher than the concentrations shown for the back ground wells.

Reference 2, page 3.18-3.20, Reference 1, page 2.20, 2.22-2.23, 3.10; Reference 21, pages 637-638, 369-370

1/12/88
ZLW

2 ROUTE CHARACTERISTICS

Depth to Aquifer of Concern

Name/description of aquifer(s) of concern:

The aquifer of concern is comprised of the unconfined aquifer and the Rattlesnake Ridge interbed.

In general, the unconfined or water table aquifer is located in the Ringold Formation and glacio fluvial sediments known as the Hanford Formation, as well as some more recent alluvial sediments in areas adjacent to the Columbia River. It is bounded below by either the basalt surface or, in places, the relatively impervious clays and silts of the lower unit of the Ringold Formation. Laterally, the unconfined aquifer is bounded by the anticlinal basalt ridges that ring the basin. The Yakima and Columbia Rivers, however, do not entirely transect these sediments and therefore do not constitute a discontinuity for HRS scoring purposes. The basalt ridges above the water table have a low permeability and act as a barrier to lateral flow of the ground water. The saturated thickness of the unconfined aquifer is greater than 61 m in some areas of the Hanford Site and pinches out along the flanks of the basalt anticlines.

There is a series of confined aquifers in the interflow zones and interbeds between the dense basalt flows that underlie the sediments containing the unconfined aquifer. When postglacial flood waters and the ancestral Columbia River flowed between Gable Mountain and Gable Butte, which are part of the Umtanum-Gable anticline, portions of the Elephant Mountain basalt flows separating the unconfined or confined aquifers were eroded creating "windows" to the lower beds. Later the water table rose to levels exceeding the potentiometric surface of the upper confined aquifer, i.e., the Rattlesnake Ridge aquifer. Thus, these erosional windows provide direct connection between the unconfined and Rattlesnake Ridge aquifers. In this area, the Rattlesnake Ridge interbed begins at 166 feet and ends at 216 feet below ground surface. Well 699-35-70, which has an observed release for tritium, has a first screened depth of 235 feet which is part of the aquifer of concern.

Several other aquifers lie below the Rattlesnake Ridge interbed including the Selah, Cold Creek and Mabton. Borings in the Gable Mountain, Gable Battle area, which support the existence of the erosional windows, do not conclusively demonstrate whether other interbeds besides the Rattlesnake are connected to the unconfined aquifer. Although sampling of the confined aquifers shows that iodine 129 is present at depths of 1,400 feet below ground surface, the data supporting these findings are insufficient to determine whether the iodine is present in the interbeds as a result of migration or as a result of contamination introduced during drilling. Therefore, further study is necessary to determine the degree of interconnection.

Reference 2, page 2.1-2.7; Reference 13, page 3.13, Reference 31;
Reference 35

Depth(s) from the ground surface to the highest seasonal level of the saturated zone [water table(s)] of the aquifer of concern:

Not applicable.

Depth from the ground surface to the lowest point of waste disposal/storage:

Not applicable.

9403218.027

1/12/88
KIA

Net Precipitation

Mean annual or seasonal precipitation (list months for seasonal):

Not applicable.

Mean annual lake or seasonal evaporation (list months for seasonal):

Not applicable.

Net precipitation (subtract the above figures):

Not applicable.

Permeability of Unsaturated Zone

Soil type in unsaturated zone:

Not applicable.

Permeability associated with soil type:

Not applicable.

Physical State

Physical state of substances at time of disposal (or at present time for generated gases):

Not applicable.

1/12/88
K129

3 CONTAINMENT

Containment

Method(s) of waste or leachate containment evaluated:

Not applicable.

Method with highest score:

Not applicable.

4 WASTE CHARACTERISTICS

Toxicity and Persistence

Compound(s) evaluated:

The 200 Area is used to process irradiated uranium fuel to recover plutonium. The area is also used to process and store waste generated during fuel processing. Substances associated with the 200 Area activities are:

dibutyl butyl phosphonate	tributyl phosphate
nitric acid	sodium dichromate
kerosene	ammonium carbonate
phosphates	sodium oxalate
sulfuric acid	ferrocyanide
fluoride	sodium silicate
sodium aluminate	sodium nitrite
methyl isobutyl ketone (MIBK)	ferrous sulfamate
aluminum fluoride nitrate	carbon tetrachloride
calcium nitrate	aluminum nitrate
magnesium nitrate	ferric nitrate
H-3	Co-60
Sr-90	Ru-106
Cs-137	Pu-239
Pu-240	uranium

Reference 1, pages 2.15-2.23; Reference 21, pages 213-662. (These pages from Reference 21 are not included in the package. Please consult the referenced document using the list of individual sites listed on the cover sheet of this package for verification of which individual sites contain which substances.) Also, see Table 1.

1/12/84
K12

Compound with highest score:

Several of the constituents listed above are assigned scores of 18. For example:

<u>Constituent</u>	<u>Toxicity</u>	<u>Persistence</u>	<u>Total Score</u>
Plutonium-239	3	3	18
Plutonium-240	3	3	18
Uranium	3	3	18
Sodium dichromate	3	3	18

Reference 4, pages 794-797; Reference 40.

Hazardous Waste Quantity

Total quantity of hazardous substances at the facility, excluding those with a containment score of 0 (Give a reasonable estimate even if quantity is above maximum):

The total waste quantity associated with the aggregate 200 Area is at least 935,149,000 cubic yards. Table 1 presents the individual liquid sites that are located within the physical confines of the 200 Area fences and the associated data that were used in creating the aggregate 200 Area Site. Table 2 presents the solid waste sites located within the physical confines of the 200 Area fences and their associated data. Also presented in Table 2 are several individual sites and their associated data that are physically located outside of the 200 Area fences, but located within the defined boundaries of the aggregated 200 Area Site. The total quantity of waste associated with the sites listed in Table 1 and Table 2 is 935,000,000 cubic yards and 149,000 cubic yards, respectively.

References are listed in Tables 1 and 2 by waste site, Reference 37.

Basis of estimating and/or computing waste quantity:

The 200 Area is used to process irradiated uranium fuel for the recovery of plutonium. Additionally the 200 Area is used to process and store waste. There are eight different operational areas within the aggregate 200 Area, PUREX Plant, B Plant, Semiworks and Critical Mass Laboratory, 200 North Area, REDOX Plant, T Plant, Plutonium Finishing Plant (PFP) (formally known as Z Plant). These eight operational areas are individually described below.

1/12/88
KPA
Revised 2/7/88
KPA

TABLE 1. Basis of Estimating and/or Computing Waste Quantity - 200 Areas

Area No. and Name	Waste Types	Years	Estimated Volume (liters)	No. of Cubic Yds	References
200 Area acidic process condensate disposal cribs, 216 series, Nos. A-5, A-15, C-1, C-6, C-10, S-1 & 2, S-7, S-9, S-23 and U-8 (8 areas)	Process condensate waste water containing nitric acid (pH~2), H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1952-1972	2,680,000,000	3,510,000	1, pages B.15 and B.17; 21, pages 219, 220, 235, 236, 401, 402, 409, 410, 465, 466, 475, 476, 479, 480, 505, 506, 597, and 598
200 Area Bismuth Phosphate Plant first cycle waste trenches, 216 series, Nos. B-35 through B-41, T-14 through T-17 and T-21 through T-25 (16 cribs)	First cycle waste contained sodium salts, fluoride, nitrate, sulfate phosphate, aluminate and radionuclides, H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1953-1954	34,100,000	44,600	1, pages B.15 and B.17; 21, pages 353-365, 535-542 and 549-458
200 Area Bismuth Phosphate Second Cycle and 224 Waste Cribs, 216 series, Nos. B-5, B-7A and B, B-8, T-3, T-5, T-6, T-7 and T-32	Second cycle and 224 waste contained sodium salts, fluoride, oxalate, nitrate, sulfate phosphate, ammonium nitrate and radionuclides Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1945-1955	299,000,000	391,000	1, pages B.15 and B.17; 21, pages 291, 292, 295, 296, 297, 298, 509, 510, 517-522, 571 and 572

11/12/88
R-32

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 North Area basin water ponds and cribs, 216 series, Nos. N-1 through N-7 (7 areas)	Fuel storage basin water containing radionuclides Sr-90, Pu-239, Cs-137 and U-238.	1944-1952	2,870,000,000	3,760,000	21, pages 449-462
200 Area scavenged TBP supernatant waste cribs and trenches, 216 series, Nos. B-14 through B-34, B-42 through B-49, B-51, B-52, T-18 and T-26 (33 areas).	Scavenged TBP waste contained sodium salts, nitrate, sulfate, phosphate, and ferrocyanide and radionuclides H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1953-1958	167,000,000	219,000	1, pages B.15 and B.17; 21, pages 311-352, 367-382, 385, 386, 387, 388, 543, 544, 559, 560
200 Area tributyl phosphate solvent waste cribs, 216 series, Nos. A-2, A-7, A-31, C-4 and U-15 (5 cribs)	Tributyl phosphate solvent wastes contained tributyl phosphate and a paraffin hydrocarbon solvent and radionuclides Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1955-1966	682,000	893	1, pages B.15 and B.17; 21, pages 215, 216, 223, 224, 263, 264, 405, 406, 605 and 606

11/2/88
KJ

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 Area ammonia scrubber and alkaline condensate waste cribs, 216 series, Nos. A-36A, B-12, B-50, S-3, S-12 and S-21 (6 cribs)	Ammonia scrubber and alkaline condensate wastes contained ammonium nitrate (except S-3) and radionuclides H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238. Wastes disposed to 216-S-3 contained sodium salts of dichromate, nitrate, aluminate and hydroxide.	1952-1973	667,000,000	873,000	1, pages B.15 and B.17; 21, pages 273, 274, 307, 308, 383, 384, 483 and 484.
200 Area analytical laboratory liquid waste cribs, 216 series, Nos. A-4, A-21, A-27, B-6, B-10A, T-2 and T-8 (7 cribs)	Laboratory waste contained nitric acid and sulfuric acid (neutralized with NaOH at 'A' cribs) and sodium dichromate. Radionuclides include Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1945-1970	130,000,000	170,000	1, pages B.15 and B.17; 21, pages 217, 218, 247, 248, 259, 260, 293, 294, 301, 302, 507, 508, 523 and 524.

11/12/88
KJ

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 Area steam condensate and/or cooling water disposal areas, 216 series, Nos. A-11, A-12, A-32 through A-35, A-40, S-5, S-6, S-16P, S-16D, S-17, T-4-1(D), T-4-1(P), U-9, U-11, Z-1(D), Z-11, T-4-2 (19 areas)	Steam condensate and/or cooling water containing nitrate and radionuclides H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1944-1979	98,600,000,000	129,000,000	1, pages B.15 and B.17; 21, pages 227, 228, 229, 230, 265 through 272, 277, 278, 471, 472, 473, 474, 491, 492, 493, 494, 495, 496, 511, 512, 513, 514, 599, 600, 601, 602, 609, 610, 629, 630, 515, 516.
200 Area Z Plant waste water disposal areas, 216 series, Nos. Z-1A, Z-142, Z-3 and Z-12 (4 areas)	Z Plant waste water contained sodium nitrate, fluoride, and radionuclides Pu-239, Sr-90, Cs-137 and U-138.	1949-1973	499,000,000	653,000	1, page B.17; 21, pages 607, 608, 611, 612, 613, 614, 631 and 632.

11/12/88
28/2/11

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 Area plutonium recovery plant waste water cribs, 216-Z-9 and 216-Z-18.	Plutonium recovery plant waste water contains sodium salts, nitrate, sulfate, aluminum fluoride nitrate, aluminum nitrate, magnesium nitrate and calcium nitrate. The waste discharged to the 216-Z-18 also contained carbon tetrachloride, tributyl phosphate and dibutyl butyl phosphorate. Radionuclides include Pu-239 in both cribs and Sr-90, Cs-137, Co-60 and U-238 in 216-Z-9.	1955-1973	7,950,000	10,400	1, page B.17; 21, pages 625, 626, 637 and 639.
200 Area caustic waste areas, 216-T-33, 216-T-36 and 216-Z-8.	Caustic waste water containing sodium hydroxide and radionuclides Pu-239 in all three areas and Sr-90, Cs-137, Co-60 and U-238 in 216-T-33 and 216-T-36.	1955-1969	2,430,000	3,180	1, page B.17; 21, pages 573, 574, 579, 580, 623 and 624.

11/2/88
KJG

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 Area chemical sewer areas, 216-B-21, 216-B-2-2 and 216-S-11.	Chemical sewer discharged unknown quantities of chemicals plus radio-nuclides Sr-90, Pu-239, Cs-137 and U-238.	1945-1965	304,000,000,000	398,000,000	1, pages B.15 and B.17; 21, pages 282, 283, 284, 285, 481 and 482.
200 Area cribs that received 300 Area crib waste, 216 series, Nos. B-53A, B-53B, B-54, T-27, T-34 and T-35 (7 cribs)	300 Area crib waste contained nitrate and radionuclides Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1962-1967	31,800,000	41,000	1, pages B.15 and B.17; 21, pages 389-394, 561, 562, 575, 576, 577 and 578.
200 Area A-Tank Farm condensate crib, 216-A-24	A-Tank Farm condensate contained butyl phosphates, paraffin hydrocarbon, ammonium carbonate and radio-nuclides H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1958-1966	820,000,000	1,020,000	1, page B.15; 21, pages 255 and 256.

11/12/88
B.15

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 Area Redox hexone-bearing wastes, 216-S-13 and 216-S-14	Sodium hexone-bearing wastes containing methyl isobutyl ketone and radionuclides Sr-90, Pu-239, Cs-137, Co-60 and U-238. In addition to the above, waste disposed to 216-S-13 contained aqueous sodium nitrate and sodium dichromate.	1951-1972	5,010,000	6,560	1, page B.17; 21, pages 485, 486, 487 and 488.
200 Area, 221-U, 222-U and 224-U liquid wastes disposed to 216-U-142 and 216-U-4A cribs	U Area wastes containing sodium nitrate and sodium phosphate and radionuclides U-238, Sr-90, Cs-137, Co-60 and Pu-239. Crib 216-U-1 & 2 also received sodium sulfate.	1951-1970	160,000,000	209,000	1, page B.17; 21, pages 581, 582, 587 and 588.

11/12/88
KJB

Area No. and Name	Waste Types	Years	Estimated Volume (liters)	No. of Cubic Yds	References
200 Area miscellaneous liquid wastes, 216 series, A-1, A-6, A-9, A-13, A-14, A-16, A-17, A-18, A-19, A-20, A-22, A-23A, A-23B, A-26A, A-28, A-39, A-41, B-3-1, B-3-2, B-4, B-9, B-10B, B-11A & B, B-13, B-57, C-3, C-5, C-8, S-4, S-8, S-15, S-18, S-20, S-22, T-9, T-10, T-11, T-12, T-13, T-20, T-28, T-29, T-30, U-3, U-4, U-4B, U-5, U-6, U-7, U-13, Z-4, Z-5, Z-6, Z-10, Z-16, Z-17 (55. areas)	Miscellaneous waste- waters containing nitrate and radio- nuclides Sr-90, Pu-239, Cs-137, Co-60, and U-238. In addition, areas 216-A-9. 216-S-4. and 216-T-30 received H-3.	1945-1979	303,000,000,000	397,000,000	1, pages B.15 and B.17; 21, pages 213, 214, 221, 222, 225, 226, 231- 234, 237-246, 249-258, 261, 262, 275, 276, 279, 280, 285- 290, 299, 300, 303-306, 309, 310, 395, 396, 403, 404, 407, 408, 411, 412, 469, 470, 477, 478, 489, 490, 497-500, 503, 504, 525-534, 547, 548, 563- 570, 583-586, 589-596, 603, 604, 615-620, 627, 628 and 633-636.
TOTAL				935,000,000 yd ³	

11/12/88
K279

TABLE 2. Basis of Estimating and/or Computing Waste Quantity - 200 Areas

Area No. and Name	Waste Types	Years	Estimated Volume (ft ³)	No. of Cubic Yds	References
200 Area dry waste burial site, 218 series, Nos. E-1, E-2, E-3, E-5, E-6, E-7, E-8, E-12A, W-1, W-2, W-3, W-4A, W-7 and W-8	Dry waste containing radionuclides Sr-90, Pu-239, Cs-137 and U-238.	1944-1968	2,960,000	110,000	1, pages B.15 and B.17; 21, pages 415-418, 421, 422, 425, 426, 429-434, 437, 438, 639, 640, 643-652. 5, Section I NW; and 6.
200 Area regulated equipment burial site, 218 series, Nos. E-2A, E-5A, E-9, E-14, W-1A, W-9 and W-11	Discarded process equipment containing radionuclides SR-90, Pu-239, Cs-137 and U-235.	1944-1964	960,000	36,000	1, pages B.15 and B.17; 21, pages 419, 420, 427, 428, 435, 436, 441, 442, 639, 640, 653, 654, 655 and 565; 5, Sections I NW, I SE; and 6.
200 Area repair and construction waste burial sites 218-E-4 and 218-E-13.	Repair and construction waste containing radionuclides SR-90, Pu-239, Cs-137 and U-238.	1955-1966	58,400	2,200	1, pages B.17; 21, pages 423, 424, 439 and 440; 5, Section I NW.

11/12/88
KCF

Area No. and Name	Waste Types	Years	Estimated Volume (ft ³)	No. of Cubic Yds	References
200 Area burning pits 200E, 200W, and Z Plant	200E and 200W received construction and office wastes plus paint waste and chemical solvents. Z Plant received office and laboratory waste.	1950-1970	21,500	800	1, pages B.15 and B.17; 21, pages 443, 444, 659, 660, 661 and 662
200 Area nonradioactive repair and construction waste burial sites, construction pit and nonradioactive burial ground	Construction pit received broken concrete and the nonradioactive burial ground received unusable plumbing materials. No radioactive waste was deliberately buried at these sites.	1945-1955	No data	No data	1, pages B.15 and B.17; 21, pages 445, 446 657 and 658.
600 Area dry waste burial sites 618-10 and 618-11	Dry waste containing Sr-90, Pu-239, Cs-137 and U-238	1953-1967	No data	No data	1, page B.21; 21, pages 693-696.
P-11 crib	Waste water containing Pu-239. Site has been exhumed.	1951-1951	No data	No data	1, page B.21; 21, pages 701 and 702.
213 J and K cribs	Drainage from plutonium storage vaults. No Pu-239 had been detected in piping. Cribs exhumed.	1944-1950	No data	No data	1, page B.21; 21, pages 703-704.

11/12/13
12/13

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (ft³)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
Miscellaneous nonradioactive burial sites, J. A. Jones No. 1 and Original Central Landfill	Miscellaneous nonradioactive wastes. No known chemical disposal.	1973-1979	Unknown quantity.	Unknown quantity.	1, page 8.21; 21, pages 705, 706, 711 and 712. 38, pages 1 and 2
			TOTAL	149,000	

11/12/98
KLB

2400 9126 16 013218 0022

PUREX Plant. The Plutonium URanium EXtraction (PUREX) Plant is the most recently constructed of the Irradiated-fuel processing plants. Constructed between April 1953 and October 1955, the PUREX Plant took over fuel-processing operations from the REDuction OXidation (REDOX) Plant. The PUREX Plant was operated from 1956 to 1972; in 1972 it was placed in operational standby mode. Plant operations were resumed in 1983.

At this facility, uranium, plutonium, and neptunium are separated from fission products found in the production reactors' irradiated uranium fuel. The process steps involve fuel-element decladding, uranium metal dissolution, solvent extraction, ion exchange, and product loadout.

Zirconium cladding on fuel elements is removed in an ammonium fluoride-ammonium nitrate (AFAN) solution. Ammonium fluoride reacts with the zirconium, resulting in a soluble zirconium compound. The ammonia and hydrogen evolved during decladding present a potential combustion hazard. Therefore, hydrogen is converted to ammonia by reaction with ammonium nitrate present in the AFAN solution. The dissolver solution is then processed to remove plutonium and uranium that dissolved with the cladding. Gas released from the dissolver is treated to remove iodine in a silver reactor, is acid-adsorbed, and is only then released to the atmosphere. The off-gases are treated with hydrogen peroxide to remove nitrogen oxides before being released to the atmosphere.

Declad fuel elements are dissolved in nitric acid for the solvent extraction processes. An organic solvent is used to separate the uranium, plutonium, and neptunium from associated fission products and from each other. The organic solvent used in a series of extraction and stripping operations is a 30% solution of tributyl phosphate in a normal paraffin hydrocarbon (kerosene) diluent.

The first extraction cycle separates the bulk of the fission products from the plutonium, uranium, and neptunium; the fission products remain in the aqueous phase. The organic phase is sent to the partitioning cycle where the plutonium is partitioned from the uranium and neptunium. The plutonium stream is routed through two additional solvent-extraction cycles for further purification. After purification, the plutonium stream is concentrated.

From 1956 to 1972, the concentrated plutonium nitrate solution was sent to the plutonium finishing operations located in the 200-West Area. When the PUREX Plant resumed operations in 1983, an additional facility was added that produced plutonium oxide from the plutonium nitrate.

The other stream from the partition cycle, which bears the neptunium and uranium, is routed to the final uranium cycle where neptunium is separated. The aqueous neptunium stream is sent to the back-cycle waste system for concentration and recycling to the solvent-extraction column. The uranium stream is routed to a column that strips the uranium from the organic stream with an aqueous nitric acid solution; concentration of the aqueous solution follows. The uranium product, uranyl nitrate hexahydrate (UNH), is then stored in tanks until it is shipped to the UO₃ plant in the 200-West Area.

9443218.0213

A portion of the concentrated neptunium solution from the final uranium cycle is sent to the neptunium recovery and purification cycle. In this cycle, neptunium is separated from the uranium, plutonium, and the remaining fission products in the neptunium stream. This separation is accomplished by a series of extractions and ion-exchange columns. The plutonium and uranium fractions are recycled to the back-cycle waste system and partitioning cycle, respectively.

Supporting process systems include organic solvent decontamination and recovery, nitric acid recovery, and waste concentration and recovery.

B Plant. The B Plant, one of the original fuels-separation facilities, was constructed between August 1943 and February 1945; it was operated until 1952. The plant used the bismuth phosphate process to separate plutonium from irradiated uranium fuel. This process produced a very dilute waste stream that contained the uranium and most of the fission products from the fuel elements. Unlike the PUREX process, the bismuth phosphate process separated plutonium from uranium and fission products by precipitating the plutonium onto a bismuth phosphate carrier.

The uranium fuel elements processed by the bismuth phosphate process were jacketed with aluminum. These jackets were removed in a sodium hydroxide-sodium nitrate ($\text{NaOH}-\text{NaNO}_3$) solution, with the NaNO_3 acting as a hydrogen scavenger. Some of the silicon used as a binder in the fuel elements was dissolved during jacket removal. This operation produced sodium silicate, sodium aluminate, and sodium nitrite.

After jacket removal, the fuel elements were dissolved in nitric acid; sulfuric acid was then added to complex the uranium. Complexing of uranium prevented it from being precipitated as uranyl phosphate during later plutonium precipitation. The metal solution was pre-treated with sodium nitrite to oxidize or reduce plutonium to the correct state for precipitation. Bismuth phosphate was then added to the metal solution and the resulting slurry was centrifuged. The solid cake was redissolved in nitric acid for further decontamination of the plutonium.

The decontamination involved several dissolutions and subsequent precipitations of plutonium. Sodium bismuthate and sodium dichromate were used as oxidizing agents, and sodium nitrite or oxalic acid was used as a reducing agent during the plutonium decontamination. The final plutonium precipitate was washed with ammonium nitrate.

The next process involved transferring the plutonium from the bismuth phosphate carrier to a lanthanum fluoride carrier. Hydrofluoric acid was used to acidify the transfer solution and cause lanthanum fluoride to precipitate, carrying the plutonium with it. Potassium hydroxide was used to change the lanthanum precipitate into a soluble compound; then the precipitate was dissolved in nitric acid.

The plutonium was then reduced using ammonium sulphate and precipitated as a peroxide by the addition of hydrogen peroxide. The plutonium peroxide was dissolved into nitric acid. This solution was concentrated to produce the

final plutonium nitrate product, which was originally shipped off site for conversion to plutonium oxide or plutonium metal.

In 1968, the B Plant was converted to a waste-fractionization plant as part of a program to solidify high-level waste. The B Plant now functions to remove cesium and strontium from PUREX current acid waste and from high-level supernatant liquids, as well as sludges from self-boiling liquid waste.

The solids are removed from the current acid waste and treated for strontium removal, and the liquid is treated with phosphotungstic acid to precipitate the cesium. The supernatant liquid is sent to a series of solvent extraction columns, similar to those used at the PUREX Plant, to remove and purify any remaining strontium. The cesium precipitate is redissolved in sodium hydroxide and treated in ion exchange columns for further purification. Liquid from stored waste is treated the same as current acid waste, except that the solids have already separated in the storage tanks. Sludge from the storage tanks and solids from current acid waste are dissolved in an acid solution and sent to the solvent-extraction columns for strontium removal.

Cesium solutions are converted to cesium chloride by the addition of hydrochloric acid. The liquid is evaporated to yield solid cesium chloride. This solid is encapsulated in Hasteloy cylinders and stored in an underwater storage basin at B Plant.

Strontium is precipitated as strontium fluoride by the addition of sodium fluoride. The strontium fluoride is filtered, dried, and encapsulated in Hasteloy cylinders. These cylinders, like the cesium cylinders, are stored in an underwater storage basin at B Plant.

Semiworks and Critical Mass Laboratory. The Semiworks was built in 1949 as a pilot plant for the REDOX Process; it was later converted to pilot the PUREX process. The Semiworks originally operated from 1952 to 1957. In 1960, the Semiworks was reactivated and equipped for the processing and loadout of fission products; it then operated as both a production and a process demonstration pilot project for converting the B Plant to a waste-partitioning facility. In 1967, the Semiworks was shut down, and it is now being decontaminated and decommissioned. Chemical processes at this facility were similar to those at the REDOX and PUREX plants.

At the Critical Mass Laboratory, research focuses on the criticality safety of plutonium in various forms and combinations with other elements. The resulting data are used to verify analytical methods that predict criticality safety for plutonium in various fuel cycles.

200 North Area. The 200 North Area was built for the ageing of "green" fuel (recently irradiated fuel) to allow for the decay of short lived radionuclides before processing the fuel. Irradiated fuel was stored in water basins while the decay process was proceeding. The area was only used during the first several years of operations, when it was discovered that the required fuel ageing time was much shorter than originally predicted. This discovery allowed the use of the 200 Area to be discontinued in 1952. Several of the sites within the 200 North Area only received waste during the pre-retirement cleaning of the basins actually used to store fuel.

200-West Area Plants

U Plant. Although the U Plant (constructed between 1943 and 1944) was one of the three original fuels-separation facilities designed to use the bismuth phosphate process, it was never used for that purpose.

Uranium was not recovered by the bismuth phosphate extraction of plutonium from irradiated fuel. However, the later-developed REDOX and PUREX processes recovered the uranium, which still had economic value. Following startup of the REDOX Plant, the U Plant was converted to recover the uranium from stored radioactive waste. From 1952 to 1958, stored waste was transferred to the U Plant for uranium recovery. The resultant sludge was dissolved in nitric acid, and then the uranium was extracted using tributyl phosphate in a normal paraffin diluent. This process left the fission products, sulfate, and phosphate ions in the aqueous acid solution. The uranium was then stripped from the organic solvent with nitric acid. This nitric acid solution was concentrated and sent to the uranium oxide process.

Although the uranium recovery processing is no longer going on, the adjacent uranium oxide plant is still operational. This plant received uranyl nitrate solution from the recovery process and from the REDOX Plant and calcined it to uranium trioxide. The uranium oxide plant now processes the product uranium from the PUREX Plant. Nitric acid is recycled to the PUREX process as a by-product of the calcination process. The uranium trioxide is shipped offsite for use as nuclear fuel.

REDOX Plant. The REDOX process for fuels separation succeeded the bismuth phosphate process and preceded the PUREX process. The REDOX Plant was constructed from May 1950 to August 1951; it operated until it was shut down in July 1967. An analytical laboratory near the facility is still operational. This laboratory supports B-Plant operations and performs research and development in support of waste management and environmental control operations. The laboratory also functions as a backup laboratory to the PUREX and Z-Plant analytical laboratories.

The REDOX Plant used a solvent extraction process to separate uranium and plutonium from fission products and each other. Methyl isobutyl ketone (MIBK) was the organic solvent that was used.

The fuel elements were prepared for nitric acid dissolution using the methods from the bismuth phosphate process. Sodium dichromate was added to the nitric acid solvent to oxidize plutonium to a state suitable for organic extraction.

Aluminum nitrate was added to the acid solution as a salting agent for the first extraction column. This salting agent caused the uranium and plutonium to be preferentially extracted by MIBK, leaving the fission products in the aqueous phase. In a second extraction column, a reducing agent was added to the aqueous phase to reduce the plutonium so that it would be removed from the uranium and extracted into the aqueous phase. The organic uranium solution and the aqueous-plutonium solution were then processed separately.

purified further, and concentrated into their respective products; uranium nitrate hexahydrate (UNH) and plutonium nitrate. The plutonium nitrate was sent to the Z Plant for processing into plutonium oxide or plutonium metal. The UNH was sent to the uranium oxide plant.

The organic solvent was treated for recycling by removing decomposition products and by further decontamination. Aqueous streams were concentrated, then the aluminum nitrate was converted to sodium aluminate by sodium hydroxide before disposal.

T Plant. The T Plant was one of the original bismuth phosphate fuels-separation facilities; it was constructed from June 1943 to October 1944 and operated for the bismuth phosphate process from 1944 to 1956. Since 1956, facilities in the T Plant have been used for decontamination and equipment repair.

Z Plant. Constructed in 1949, the Z Plant was the site of the plutonium Laboratory and finishing operations, including the processing of plutonium scrap materials and preparation of plutonium products. The plutonium parts preparation ceased in December 1965. A process known as "recouplex" was operated at the plant from 1955 to 1962 to recover plutonium from scrap and produce a plutonium nitrate solution. The Plutonium Reclamation Facility began operations in 1964 to perform the functions of the recouplex process.

The recouplex process used nitric acid and hydrofluoric acid to dissolve solids and a tributyl phosphate-carbon tetrachloride solvent extraction process for recovery of purified plutonium nitrate solutions. Aluminum nitrate was used to salt the aqueous streams for selective extraction of plutonium and to create complexed fluoride ions as aluminum fluoroxide nitrate to prevent their interference during plutonium extraction. Americium was also recovered in the Plutonium Reprocessing Facility using dibutyl butyl phosphonate (DBBP) in a carbon tetrachloride diluent. The DBBP has subsequently been replaced with tributyl phosphate.

The Plutonium Processing Facility converts plutonium nitrate to plutonium oxide and then to plutonium metal, if metal is the desired product. The plutonium oxide is made by precipitating the plutonium as plutonium oxalate and then calcining the precipitate. To produce metal, the plutonium oxide is first converted to plutonium fluoride. The fluoride is placed in an iron can, which is placed in a magnesium oxide crucible with calcium metal. A reducing charge is applied to the crucible to reduce the plutonium fluoride to plutonium metal, which is then molded into a button. The remaining iron, calcium, and magnesium are dissolved in nitric acid for disposal.

Reference 1, pages 2.15-2.23, Reference 21, pages 449-462.

1/12/88
TJD

5 TARGETS

Ground Water Use

Use(s) of aquifer(s) of concern within a 3-mile radius of the facility:

427-822616
043218-027

The aquifer of concern, within three miles of the facility, supplies drinking water at the Fast Flux Test Facility (FFTF). Across the Columbia River, within three miles of the 200 Area defined boundary (disposal sites and contaminant plume), there are 17 wells in the aquifer of concern. These wells consist of 14 private wells and 3 community wells. The three wells at FFTF are 294 ft deep, 399 ft deep, and 400 ft deep. These wells are screened at 188 to 281 ft, 221 to 396, and 360 to 390 ft (new deeper well) respectively. The across-river private wells vary in depth and screened intervals. No data was available concerning the depth and screen intervals of the private wells, however it was assumed that these wells were completed into the unconfined aquifer. The across-river community wells are the Eppich Water System, Cypress Gardens School well, and Rio Vista Orchards well. The wells are 88 ft deep, 160 ft deep, and 80 ft deep, respectively. Since these wells are all located in very remote locations, there is no municipal water from alternate unthreatened sources presently available.

Reference 7, pg 178; Reference 8, pg 43; Reference 2, pgs 4.7 and 3.19; Reference 9; Reference 10; Reference 11, Reference 36.

Distance to Nearest Well

Location of nearest well drawing from aquifer of concern or occupied building not served by a public water supply:

The nearest wells drawing water from the aquifer of concern are located at the Fast Flux Test Facility (FFTF) which is located within the 200 Area plume.

Reference 8; Reference 2, pg. 3.19.

Distance to above well or building:

The water supply wells at the FFTF draw water from the aquifer of concern within the defined boundary of the 200 Area. Sampling of tap water draining from these wells, which are interconnected, have shown contamination. Therefore, the distance to the nearest well is zero feet.

Reference 2, pg 3.19; Reference 8, pg 43 and 481 Bldg Tap Water Sample Report.

Population Served by Ground Water Wells Within a 3-Mile Radius

Identified water-supply well(s) drawing from aquifer(s) of concern within a 3-mile radius and populations served by each:

The water supply wells at the FFTF supply drinking water for the work force

9413218.000

at the facility which numbers 2420 people. Assuming that each across-river private well supplies drinking water to 3.8 people per well, 53.2 people are served by these wells. The 3 community wells, the Eppich Water System, the Cypress Garden School well, and the Rio Vista Orchards well serve 12 permanent residents and 8 migrant farm worker residents, 12 permanent residents, and 8 permanent residents, respectively.

Reference 10; Reference 11; Reference 12, pg 3.

Computation of land areas irrigated by supply well(s) drawing from aquifer(s) of concern within a 3-mile radius, and conversion to population (1.5 people per acre):

There are no documented wells (within three miles of the site) used for irrigation. All irrigated farm land within 3 miles of the defined boundary of the 200 Area are supplied from either the Columbia River or from the Columbia Basin irrigation project.

Total population served by ground water within a 3-mile radius:

There is a total of 2513.2 (2420 + 53.2 + 40) people served by the aquifer of concern within three miles of the 200 Area's defined boundary. This total includes workers, permanent residents, and migrant farm worker residents.

Reference 12 pg 3; Reference 10, Reference 11.

1/12/88
KLD

SURFACE WATER ROUTE

1 OBSERVED RELEASE

Contaminants detected in surface water at the facility or downhill from it (5 maximum):

Tritium and iodine-129 were used to verify observed release and define the maximum extent of contamination in surface water. Evidence of observed release can be established by comparison of upstream and down stream concentrations of tritium and iodine-129. River bank springs monitoring and localized Columbia River sampling can be used to verify observed release by demonstrating that contaminants are entering the river in this area. The following two tables present upstream and downstream concentrations for iodine-129 and tritium for 1983 (same period as the spring sampling) and 1986.

200 Area Concentrations for Iodine-129

BACKGROUND			DOWN GRADIENT		
Date	Sample Point	Concentration (pCi/L)	Date	Sample Point	Concentration (pCi/L)
1/22/83	27.0 RW	$3.3E-6 \pm 1.4E-6$	10/7/86	312 Intk	$1.61E-4 \pm 1.45E-5$
10/7/86	Prst Rap	$1.04E-5 \pm 1.29E-6$	1/22/83	29.0 RW	$6.3E-5 \pm 5.0E-6$
			<u>Springs</u>		
			9/11/83	27-1 Spg	$1.6E-4 \pm 2.1E-5$
			9/11/83	28-2 Spg	$6.2E-2 \pm 6.8E-3$
			9/11/83	31-5 Spg	$3.0E-5 \pm 4.0E-6$
			9/11/83	32-0 Spg	$4.4E-5 \pm 2.7E-5$

200 Area Concentrations for Tritium

BACKGROUND			DOWN GRADIENT		
Date	Sample Point	Concentration (pCi/L)	Date	Sample Point	Concentration (pCi/L)
Various	Prst Rap	Mean = 119 ^(a)	9/11/83	28.0 RW	60600 ± 761
9/11/83	27.0 RW	107 ± 201	Various	Rich Intk	Mean = 165 ^(a)
			<u>Spring</u>		
			9/11/83	28-2 Spg	110000 ± 995

- (a) Comparison of the 75 downstream samples (mean = 165, standard deviation = 160) to the 75 upstream samples (mean = 119, standard deviation = 108) using a one-tailed T-Test, indicated that there is a 95% probability that the downstream sample mean is significantly higher than the upstream. In addition, statistical analyses performed by DOE in 1985 and 1986 of upstream-downstream sampling data showed similar results. It is concluded, therefore, that an observed release of tritium has occurred at least as far downstream as the Richland intake.

Reference 2, Reference 3, page 17, A.5, B.3, C.6-C.7; Reference 23; Reference 25; Reference 28; Reference 30, Reference 39.

Rationale for attributing the contaminants to the facility:

Tritium and Iodine-129 are products of the fission process that are released as a result of irradiated fuel reprocessing. Thus, both of these constituents are found in certain waste disposed of into the 200 Area. Both of these constituents are highly mobile in the Hanford environment and are used as indicators of extent of contamination. The downgradient samples showed significant increases in contaminant concentrations above those found in the background samples. In addition, spring water contaminated with these elements can be shown to discharge into the river.

Reference 2, pages 3.18-3.20; Reference 1, page 3.10

2 ROUTE CHARACTERISTICS

Facility Slope and Intervening Terrain

Average slope of facility in percent:

Not applicable.

Name/description of nearest down slope surface water:

The Columbia River, which originates in the mountains of eastern British Columbia, Canada, flows through the northern edge of the Hanford Site and forms part of the Hanford Site's eastern boundary. The river drains a total area of approximately 70,800 km² enroute to the Pacific Ocean. The flow of the Columbia River is regulated by 11 dams within the United States, 7 upstream and 4 downstream of the Site. Priest Rapids Dam is the nearest impoundment upstream of the Site, and McNary Dam is the nearest dam downstream. (The Hanford reach of the Columbia River extends from Priest Rapids Dam to the head of Lake Wallula, which is created by McNary Dam.) This is the only stretch of the Columbia River within the U.S. that is not impounded by a dam. The width of the river varies from approximately 300 m to about 1000 m. The flow through this stretch of the river is relatively swift, with numerous bends and several islands present throughout the reach. The ground water beneath the site discharges directly into the Columbia River as evidenced by seeps and springs along the Columbia River.

The flow rate of the Columbia River in this region is regulated primarily by Priest Rapids Dam. Hanford reach flows fluctuate significantly because of the relatively small storage capacity and operational practices of the nearby upstream dams. A minimum flow rate of 1,000 cubic meters per second (36,000 cubic feet per second) has been established at Priest Rapids. Typical daily flows range from 1,000 cubic meters per second (36,000 cubic feet per second) to 7,000 cubic meters per second (250,000 cubic feet per second) with peak spring runoff flows of up to 12,600 cubic meters per second (450,000 cubic feet per second) being recorded. Typical annual average flows at Priest Rapids Dam are 3,100 cubic meters per second (110,000 cubic feet per second) to 3,400 cubic meters per second (120,000 cubic feet per second). Monthly mean flows typically peak from April through June and are at the lowest levels from September through October.

The depth at the deepest part of the measured cross-sections varies approximately from 10 to 40 feet, with an average around 25 feet. Daily fluctuations in depth caused by Priest Rapids regulation can be as much as 10 feet above Vernita and 5 feet at Hanford.

Reference 2, page 2.1; Reference 13, page II.3-13.

Average slope of terrain between facility and above-cited surface water body in percent:

Not applicable.

Is the facility located either totally or partially in surface water?

Not applicable.

1/12/88
KTS

Is the facility completely surrounded by areas of higher elevation?

Not applicable.

1-Year 24-Hour Rainfall in Inches

Not applicable.

Distance to Nearest Down slope Surface Water

Not applicable.

Physical State of Waste

Not applicable.

3 CONTAINMENT

Containment

Method(s) of waste or leachate containment evaluated:

Not applicable.

Method with highest score:

Not applicable.

1/12/88
KSP

4 WASTE CHARACTERISTICS

Toxicity and Persistence

Compound(s) evaluated

The 200 Area is used to process irradiated uranium fuel to recover plutonium. The area is also used to process and store waste generated during fuel processing. Substances associated with the 200 Area activities are:

dibutyl butyl phosphonate	tributyl phosphate
nitric acid	sodium dichromate
kerosene	ammonium carbonate
butyl phosphates	sodium oxalate
sulfuric acid	ferrocyanide
fluoride	sodium silicate
sodium aluminate	sodium nitrite
methyl isobutyl ketone (MIBK)	ferrous sulfamate
aluminum fluoride nitrate	carbon tetrachloride
calcium nitrate	aluminum nitrate
magnesium nitrate	ferric nitrate
H-3	Co-60
Sr-90	Ru-106
Cs-137	Pu-239
Pu-240	uranium

Reference 1, pgs. 2.15-2.23; Reference 21, pgs. 213-662. Also, see Table 1.

Compound with highest score:

Several of the constituents listed above are assigned scores of 18. For example:

<u>Constituent</u>	<u>Toxicity</u>	<u>Persistence</u>
Plutonium-239	3	3
Plutonium-240	3	3
Uranium	3	3
Sodium dichromate	3	3

Reference 4, pgs. 794-797. Reference 40.

1/12/88
KJG
Revised 2/9/88
KJG

Hazardous Waste Quantity

Total quantity of hazardous substances at the facility, excluding those with a containment score of 0 (Give a reasonable estimate even if quantity is above maximum):

The total waste quantity associated with the aggregate 200 Area is at least 935,149,000 cubic yards. Table 1 presents the individual liquid sites that are located within the physical confines of the 200 Area fences and the associated data that were used in creating the aggregate 200 Area Site. Table 2 presents the solid waste sites located within the physical confines of the 200 Area fences and their associated data. Also presented in Table 2 are several individual sites and their associated data that are physically located outside of the 200 Area fences, but located within the defined boundaries of the aggregated 200 Area Site. The total quantity of waste associated with the sites listed in Table 1 and Table 2 is 935,000,000 cubic yards and 149,000 cubic yards, respectively.

References are listed in Tables 1 and 2 by waste site; Reference 37.

Basis of estimating and/or computing waste quantity:

The ground water seeps into the surface water at springs along the Columbia River; therefore, hazardous waste quantities reported for ground water are also applicable to surface water.

Reference 8, pg 43.

The 200 Area is used to process irradiated uranium fuel for the recovery of plutonium. Additionally the 200 Area is used to process and store waste. In compiling the inventory for the 200 Area, it was assumed that since ground water seeps into the Columbia River the containment associated with the surface water route is considered not to be 0, and all the waste quantities cited were available for migration. There are eight different operational areas within the aggregate 200 Area, PUREX Plant, B Plant, Semiworks and Critical Mass Laboratory, 200 North Area, REDOX Plant, T Plant, Plutonium Finishing Plant (PFP) (formally known as Z Plant). These eight operational areas are individually described below.

1/12/88
KCN

TABLE 1. Basis of Estimating and/or Computing Waste Quantity - 200 Areas

Area No. and Name	Waste Types	Years	Estimated Volume (liters)	No. of Cubic Yds	References
200 Area acidic process condensate disposal cribs, 216 series, Nos. A-5, A-15, C-1, C-6, C-10, S-1 & 2, S-7, S-9, S-23 and U-8 (8 areas)	Process condensate waste water containing nitric acid (pH~2), H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1952-1972	2,680,000,000	3,510,000	1, pages B.15 and B.17; 21, pages 219, 220, 235, 236, 401, 402, 409, 410, 465, 466, 475, 476, 479, 480, 505, 506, 597, and 598
200 Area Bismuth Phosphate Plant first cycle waste trenches, 216 series, Nos. B-35 through B-41, T-14 through T-17 and T-21 through T-25 (16 cribs)	First cycle waste contained sodium salts, fluoride, nitrate, sulfate phosphate, aluminate and radionuclides, H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1953-1954	34,100,000	44,600	1, pages B.15 and B.17; 21, pages 353-365, 535-542 and 549-458
200 Area Bismuth Phosphate Second Cycle and 224 Waste Cribs, 216 series, Nos. B-5, B-7A and B, B-8, T-3, T-5, T-6, T-7 and T-32	Second cycle and 224 waste contained sodium salts, fluoride, oxalate, nitrate, sulfate phosphate, ammonium nitrate and radionuclides Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1945-1955	299,000,000	391,000	1, pages B.15 and B.17; 21, pages 291, 292, 295, 296, 297, 298, 509, 510, 517-522, 571 and 572

11/12/88

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 North Area basin water ponds and cribs, 216 series, Nos. N-1 through N-7 (7 areas)	Fuel storage basin water containing radionuclides Sr-90, Pu-239, Cs-137 and U-238.	1944-1952	2,870,000,000	3,760,000	1, pages 449-462
200 Area scavenged TBP supernatant waste cribs and trenches, 216 series, Nos. B-14 through B-34, B-42 through B-49, B-51, B-52, T-18 and T-26 (33 areas).	Scavenged TBP waste contained sodium salts, nitrate, sulfate, phosphate, and ferrocyanide and radionuclides H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1953-1958	167,000,000	219,000	1, pages B.15 and B.17; 21, pages 311-352, 367-382, 385, 386, 387, 388, 543, 544, 559, 560
200 Area tributyl phosphate solvent waste cribs, 216 series, Nos. A-2, A-7, A-31, C-4 and U-15 (5 cribs)	Tributyl phosphate solvent wastes contained tributyl phosphate and a paraffin hydrocarbon solvent and radionuclides Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1955-1966	682,000	893	1, pages B.15 and B.17; 21, pages 215, 216, 223, 224, 263, 264, 405, 406, 605 and 606

11/12/88
KLB

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 Area ammonia scrubber and alkaline condensate waste cribs, 216 series, Nos. A-36A, B-12, B-50, S-3, S-12 and S-21 (6 cribs)	Ammonia scrubber and alkaline condensate wastes contained ammonium nitrate (except S-3) and radionuclides H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238. Wastes disposed to 216-S-3 contained sodium salts of dichromate, nitrate, aluminate and hydroxide.	1952-1973	667,000,000	873,000	1, pages B.15 and B.17; 21, pages 273, 274, 307, 308, 383, 384, 483 and 484.
200 Area analytical laboratory liquid waste cribs, 216 series, Nos. A-4, A-21, A-27, B-6, B-10A, T-2 and T-8 (7 cribs)	Laboratory waste contained nitric acid and sulfuric acid (neutralized with NaOH at 'A' cribs) and sodium dichromate. Radionuclides include Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1945-1970	130,000,000	170,000	1, pages B.15 and B.17; 21, pages 217, 218, 247, 248, 259, 260, 293, 294, 301, 302, 507, 508, 523 and 524.

11/2/88
KLB

Area No. and Name	Waste Types	Years	Estimated Volume (liters)	No. of Cubic Yds	References
200 Area steam condensate and/or cooling water disposal areas, 216 series, Nos. A-11, A-12, A-32 through A-35, A-40, S-5, S-6, S-16P, S-16D, S-17, T-4-1(D), T-4-1(P), U-9, U-11, Z-1(D), Z-11, T-4-2 (19 areas)	Steam condensate and/or cooling water containing nitrate and radionuclides H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1944-1979	98,600,000,000	129,000,000	1, pages B.15 and B.17; 21, pages 227, 228, 229, 230, 265 through 272, 277, 278, 471, 472, 473, 474, 491, 492, 493, 494, 495, 496, 511, 512, 513, 514, 599, 600, 601, 602, 609, 610, 629, 630, 515, 516.
200 Area Z Plant waste water disposal areas, 216 series, Nos. Z-1A, Z-142, Z-3 and Z-12 (4 areas)	Z Plant waste water contained sodium nitrate, fluoride, and radionuclides Pu-239, Sr-90, Cs-137 and U-138.	1949-1973	499,000,000	653,000	1, page B.17; 21, pages 607, 608, 611, 612, 613, 614, 631 and 632.

11/12/88
K129

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 Area plutonium recovery plant waste water cribs, 216-Z-9 and 216-Z-18.	Plutonium recovery plant waste water contains sodium salts, nitrate, sulfate, aluminum fluoride nitrate, aluminum nitrate, magnesium nitrate and calcium nitrate. The waste discharged to the 216-Z-18 also contained carbon tetrachloride, tributyl phosphate and dibutyl butyl phosphorate. Radionuclides include Pu-239 in both cribs and Sr-90, Cs-137, Co-60 and U-238 in 216-Z-9.	1955-1973	7,950,000	10,400	1, page B.17; 21, pages 625, 626, 637 and 639.
200 Area caustic waste areas, 216-T-33, 216-T-36 and 216-Z-8.	Caustic waste water containing sodium hydroxide and radionuclides Pu-239 in all three areas and Sr-90, Cs-137, Co-60 and U-238 in 216-T-33 and 216-T-36.	1955-1969	2,430,000	3,180	1, page B.17; 21, pages 573, 574, 579, 580, 623 and 624.

11/12/88
KJ

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 Area chemical sewer areas, 216-B-21, 216-B-2-2 and 216-S-11.	Chemical sewer discharged unknown quantities of chemicals plus radionuclides Sr-90, Pu-239, Cs-137 and U-238.	1945-1965	304,000,000,000	398,000,000	1, pages B.15 and B.17; 21, pages 282, 283, 284, 285, 481 and 482.
200 Area cribs that received 300 Area crib waste, 216 series, Nos. B-53A, B-53B, B-54, T-27, T-34 and T-35 (7 cribs)	300 Area crib waste contained nitrate and radionuclides Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1962-1967	31,800,000	41,000	1, pages B.15 and B.17; 21, pages 389-394, 561, 562, 575, 576, 577 and 578.
200 Area A-Tank Farm condensate crib, 216-A-24	A-Tank Farm condensate contained butyl phosphates, paraffin hydrocarbon, ammonium carbonate and radionuclides H-3, Sr-90, Pu-239, Cs-137, Co-60 and U-238.	1958-1966	820,000,000	1,020,000	1, page B.15; 21, pages 255 and 256.

11/12/88
KQ

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (liters)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
200 Area Redox hexone-bearing wastes, 216-S-13 and 216-S-14	Sodium hexone-bearing wastes containing methyl isobutyl ketone and radionuclides Sr-90, Pu-239, Cs-137, Co-60 and U-238. In addition to the above, waste disposed to 216-S-13 contained aqueous sodium nitrate and sodium dichromate.	1951-1972	5,010,000	6,560	1, page B.17; 21, pages 485, 486, 487 and 488.
200 Area, 221-U, 222-U and 224-U liquid wastes disposed to 216-U-142 and 216-U-4A cribs	U Area wastes containing sodium nitrate and sodium phosphate and radionuclides U-238, Sr-90, Cs-137, Co-60 and Pu-239. Crib 216-U-1 & 2 also received sodium sulfate.	1951-1970	160,000,000	209,000	1, page B.17; 21, pages 581, 582, 587 and 588.

11/12/88
KLP

Area No. and Name	Waste Types	Years	Estimated Volume (liters)	No. of Cubic Yds	References
200 Area miscellaneous liquid wastes, 216 series, A-1, A-6, A-9, A-13, A-14, A-16, A-17, A-18, A-19, A-20, A-22, A-23A, A-23B, A-26A, A-28, A-39, A-41, B-3-1, B-3-2, B-4, B-9, B-10B, B-11A & B, B-13, B-57, C-3, C-5, C-8, S-4, S-8, S-15, S-18, S-20, S-22, T-9, T-10, T-11, T-12, T-13, T-20, T-28, T-29, T-30, U-3, U-4, U-4B, U-5, U-6, U-7, U-13, Z-4, Z-5, Z-6, Z-10, Z-16, Z-17 (55 areas)	Miscellaneous waste- waters containing nitrate and radio- nuclides Sr-90, Pu-239, Cs-137, Co-60, and U-238. In addition, areas 216-A-9. 216-S-4. and 216-T-30 received H-3.	1945-1979	303,000,000,000	397,000,000	1, pages B.15 and B.17; 21, pages 213, 214, 221, 222, 225, 226, 231- 234, 237-246, 249-258, 261, 262, 275, 276, 279, 280, 285- 290, 299, 300, 303-306, 309, 310, 395, 396, 403, 404, 407, 408, 411, 412, 469, 470, 477, 478, 489, 490, 497-500, 503, 504, 525-534, 547, 548, 563- 570, 583-586, 589-596, 603, 604, 615-620, 627, 628 and 633-636.
TOTAL				935,000,000 yd ³	

11/12/88
1237

TABLE 2. Basis of Estimating and/or Computing Waste Quantity - 200 Areas

Area No. and Name	Waste Types	Years	Estimated Volume (ft ³)	No. of Cubic Yds	References
200 Area dry waste burial site, 218 series, Nos. E-1, E-2, E-3, E-5, E-6, E-7, E-8, E-12A, W-1, W-2, W-3, W-4A, W-7 and W-8	Dry waste containing radionuclides Sr-90, Pu-239, Cs-137 and U-238.	1944-1968	2,960,000	110,000	1, pages B.15 and B.17; 21, pages 415-418, 421, 422, 425, 426, 429-434, 437, 438, 639, 640, 643-652; 5, Section I NW; and 6.
200 Area regulated equipment burial site, 218 series, Nos. E-2A, E-5A, E-9, E-14, W-1A, W-9 and W-11	Discarded process equipment containing radionuclides SR-90, Pu-239, Cs-137 and U-235.	1944-1964	960,000	36,000	1, pages B.15 and B.17; 21, pages 419, 420, 427, 428, 435, 436, 441, 442, 639, 640, 653, 654, 655 and 565; 5, Sections I NW, I SE; and 6.
200 Area repair and construction waste burial sites 218-E-4 and 218-E-13.	Repair and construction waste containing radionuclides SR-90, Pu-239, Cs-137 and U-238.	1955-1966	58,400	2,200	1, pages B.17; 21, pages 423, 424, 439 and 440; 5, Section I NW.

11/12/88
KJP

Area No. and Name	Waste Types	Years	Estimated Volume (ft ³)	No. of Cubic Yds	References
200 Area burning pits 200E, 200W, and Z Plant	200E and 200W received construction and office wastes plus paint waste and chemical solvents. Z Plant received office and laboratory waste.	1950-1970	21,500	800	1, pages B.15 and B.17; 21, pages 443, 444, 659, 660, 661 and 662
200 Area nonradioactive repair and construction waste burial sites, construction pit and nonradioactive burial ground	Construction pit received broken concrete and the nonradioactive burial ground received unusable plumbing materials. No radioactive waste was deliberately buried at these sites.	1945-1955	No data	No data	1, pages B.15 and B.17; 21, pages 445, 446 657 and 658.
600 Area dry waste burial sites 618-10 and 618-11	Dry waste containing Sr-90, Pu-239, Cs-137 and U-238	1953-1967	No data	No data	1, page B.21; 21, pages 693-696.
P-11 crib	Waste water containing Pu-239. Site has been exhumed.	1951-1951	No data	No data	1, page B.21; 21, pages 701 and 702.
213 J and K cribs	Drainage from plutonium storage vaults. No Pu-239 had been detected in piping. Cribs exhumed.	1944-1950	No data	No data	1, page B.21; 21, pages 703-704.

11/2/88
K279

<u>Area No. and Name</u>	<u>Waste Types</u>	<u>Years</u>	<u>Estimated Volume (ft³)</u>	<u>No. of Cubic Yds</u>	<u>References</u>
Miscellaneous nonradioactive burial sites, J. A. Jones No. 1 and Original Central Landfill	Miscellaneous nonradioactive wastes. No known chemical disposal.	1973-1979	Unknown quantity.	Unknown quantity.	1, page B.21; 21, pages 705, 706, 711 and 712; 38, pages 1 and 2
TOTAL				149,000	

11/2/88
KIC

993218-0266

PUREX Plant. The Plutonium URanium EXtraction (PUREX) Plant is the most recently constructed of the irradiated-fuel processing plants. Constructed between April 1953 and October 1955, the PUREX Plant took over fuel-processing operations from the REDuction OXidation (REDOX) Plant. The PUREX Plant was operated from 1956 to 1972; in 1972 it was placed in operational standby mode. Plant operations were resumed in 1983.

At this facility, uranium, plutonium, and neptunium are separated from fission products found in the production reactors' irradiated uranium fuel. The process steps involve fuel-element decladding, uranium metal dissolution, solvent extraction, ion exchange, and product loadout.

Zirconium cladding on fuel elements is removed in an ammonium fluoride-ammonium nitrate (AFAN) solution. Ammonium fluoride reacts with the zirconium, resulting in a soluble zirconium compound. The ammonia and hydrogen evolved during decladding present a potential combustion hazard. Therefore, hydrogen is converted to ammonia by reaction with ammonium nitrate present in the AFAN solution. The dissolver solution is then processed to remove plutonium and uranium that dissolved with the cladding. Gas released from the dissolver is treated to remove iodine in a silver reactor, is acid-adsorbed, and is only then released to the atmosphere. The off-gases are treated with hydrogen peroxide to remove nitrogen oxides before being released to the atmosphere.

Declad fuel elements are dissolved in nitric acid for the solvent extraction processes. An organic solvent is used to separate the uranium, plutonium, and neptunium from associated fission products and from each other. The organic solvent used in a series of extraction and stripping operations is a 30% solution of tributyl phosphate in a normal paraffin hydrocarbon (kerosene) diluent.

The first extraction cycle separates the bulk of the fission products from the plutonium, uranium, and neptunium; the fission products remain in the aqueous phase. The organic phase is sent to the partitioning cycle where the plutonium is partitioned from the uranium and neptunium. The plutonium stream is routed through two additional solvent-extraction cycles for further purification. After purification, the plutonium stream is concentrated.

From 1956 to 1972, the concentrated plutonium nitrate solution was sent to the plutonium finishing operations located in the 200-West Area. When the PUREX Plant resumed operations in 1983, an additional facility was added that produced plutonium oxide from the plutonium nitrate.

The other stream from the partition cycle, which bears the neptunium and uranium, is routed to the final uranium cycle where neptunium is separated. The aqueous neptunium stream is sent to the back-cycle waste system for concentration and recycling to the solvent-extraction column. The uranium stream is routed to a column that strips the uranium from the organic stream with an aqueous nitric acid solution; concentration of the aqueous solution follows. The uranium product, uranyl nitrate hexahydrate (UNH), is then stored in tanks until it is shipped to the UO₃ plant in the 200-West Area.

943218.0267

A portion of the concentrated neptunium solution from the final uranium cycle is sent to the neptunium recovery and purification cycle. In this cycle, neptunium is separated from the uranium, plutonium, and the remaining fission products in the neptunium stream. This separation is accomplished by a series of extractions and ion-exchange columns. The plutonium and uranium fractions are recycled to the back-cycle waste system and partitioning cycle, respectively.

Supporting process systems include organic solvent decontamination and recovery, nitric acid recovery, and waste concentration and recovery.

B Plant. The B Plant, one of the original fuels-separation facilities, was constructed between August 1943 and February 1945; it was operated until 1952. The plant used the bismuth phosphate process to separate plutonium from irradiated uranium fuel. This process produced a very dilute waste stream that contained the uranium and most of the fission products from the fuel elements. Unlike the PUREX process, the bismuth phosphate process separated plutonium from uranium and fission products by precipitating the plutonium onto a bismuth phosphate carrier.

The uranium fuel elements processed by the bismuth phosphate process were jacketed with aluminum. These jackets were removed in a sodium hydroxide-sodium nitrate (NaOH-NaNO_3) solution, with the NaNO_3 acting as a hydrogen scavenger. Some of the silicon used as a binder in the fuel elements was dissolved during jacket removal. This operation produced sodium silicate, sodium aluminate, and sodium nitrite.

After jacket removal, the fuel elements were dissolved in nitric acid; sulfuric acid was then added to complex the uranium. Complexing of uranium prevented it from being precipitated as uranyl phosphate during later plutonium precipitation. The metal solution was pre-treated with sodium nitrite to oxidize or reduce plutonium to the correct state for precipitation. Bismuth phosphate was then added to the metal solution and the resulting slurry was centrifuged. The solid cake was redissolved in nitric acid for further decontamination of the plutonium.

The decontamination involved several dissolutions and subsequent precipitations of plutonium. Sodium bismuthate and sodium dichromate were used as oxidizing agents, and sodium nitrite or oxalic acid was used as a reducing agent during the plutonium decontamination. The final plutonium precipitate was washed with ammonium nitrate.

The next process involved transferring the plutonium from the bismuth phosphate carrier to a lanthanum fluoride carrier. Hydrofluoric acid was used to acidify the transfer solution and cause lanthanum fluoride to precipitate, carrying the plutonium with it. Potassium hydroxide was used to change the lanthanum precipitate into a soluble compound; then the precipitate was dissolved in nitric acid.

The plutonium was then reduced using ammonium sulphate and precipitated as a peroxide by the addition of hydrogen peroxide. The plutonium peroxide was dissolved into nitric acid. This solution was concentrated to produce the

final plutonium nitrate product, which was originally shipped off site for conversion to plutonium oxide or plutonium metal.

In 1968, the B Plant was converted to a waste-fractionization plant as part of a program to solidify high-level waste. The B Plant now functions to remove cesium and strontium from PUREX current acid waste and from high-level supernatant liquids, as well as sludges from self-boiling liquid waste.

The solids are removed from the current acid waste and treated for strontium removal, and the liquid is treated with phosphotungstic acid to precipitate the cesium. The supernatant liquid is sent to a series of solvent extraction columns, similar to those used at the PUREX Plant, to remove and purify any remaining strontium. The cesium precipitate is redissolved in sodium hydroxide and treated in ion exchange columns for further purification. Liquid from stored waste is treated the same as current acid waste, except that the solids have already separated in the storage tanks. Sludge from the storage tanks and solids from current acid waste are dissolved in an acid solution and sent to the solvent-extraction columns for strontium removal.

Cesium solutions are converted to cesium chloride by the addition of hydrochloric acid. The liquid is evaporated to yield solid cesium chloride. This solid is encapsulated in Hasteloy cylinders and stored in an underwater storage basin at B Plant.

Strontium is precipitated as strontium fluoride by the addition of sodium fluoride. The strontium fluoride is filtered, dried, and encapsulated in Hasteloy cylinders. These cylinders, like the cesium cylinders, are stored in an underwater storage basin at B Plant.

Semiworks and Critical Mass Laboratory. The Semiworks was built in 1949 as a pilot plant for the REDOX Process; it was later converted to pilot the PUREX process. The Semiworks originally operated from 1952 to 1957. In 1960, the Semiworks was reactivated and equipped for the processing and loadout of fission products; it then operated as both a production and a process demonstration pilot project for converting the B Plant to a waste-partitioning facility. In 1967, the Semiworks was shut down, and it is now being decontaminated and decommissioned. Chemical processes at this facility were similar to those at the REDOX and PUREX plants.

At the Critical Mass Laboratory, research focuses on the criticality safety of plutonium in various forms and combinations with other elements. The resulting data are used to verify analytical methods that predict criticality safety for plutonium in various fuel cycles.

200 North Area. The 200 North Area was built for the ageing of "green" fuel (recently irradiated fuel) to allow for the decay of short lived radionuclides before processing the fuel. Irradiated fuel was stored in water basins while the decay process was proceeding. The area was only used during the first several years of operations, when it was discovered that the required fuel ageing time was much shorter than originally predicted. This discovery allowed the use of the 200 Area to be discontinued in 1952. Several of the sites within the 200 North Area only received waste during the pre-retirement cleaning of the basins actually used to store fuel.

200-West Area Plants

U Plant. Although the U Plant (constructed between 1943 and 1944) was one of the three original fuels-separation facilities designed to use the bismuth phosphate process, it was never used for that purpose.

Uranium was not recovered by the bismuth phosphate extraction of plutonium from irradiated fuel. However, the later-developed REDOX and PUREX processes recovered the uranium, which still had economic value. Following startup of the REDOX Plant, the U Plant was converted to recover the uranium from stored radioactive waste. From 1952 to 1958, stored waste was transferred to the U Plant for uranium recovery. The resultant sludge was dissolved in nitric acid, and then the uranium was extracted using tributyl phosphate in a normal paraffin diluent. This process left the fission products, sulfate, and phosphate ions in the aqueous acid solution. The uranium was then stripped from the organic solvent with nitric acid. This nitric acid solution was concentrated and sent to the uranium oxide process.

Although the uranium recovery processing is no longer going on, the adjacent uranium oxide plant is still operational. This plant received uranyl nitrate solution from the recovery process and from the REDOX Plant and calcined it to uranium trioxide. The uranium oxide plant now processes the product uranium from the PUREX Plant. Nitric acid is recycled to the PUREX process as a by-product of the calcination process. The uranium trioxide is shipped offsite for use as nuclear fuel.

REDOX Plant. The REDOX process for fuels separation succeeded the bismuth phosphate process and preceded the PUREX process. The REDOX Plant was constructed from May 1950 to August 1951; it operated until it was shut down in July 1967. An analytical laboratory near the facility is still operational. This laboratory supports B-Plant operations and performs research and development in support of waste management and environmental control operations. The laboratory also functions as a backup laboratory to the PUREX and Z-Plant analytical laboratories.

The REDOX Plant used a solvent extraction process to separate uranium and plutonium from fission products and each other. Methyl isobutyl ketone (MIBK) was the organic solvent that was used.

The fuel elements were prepared for nitric acid dissolution using the methods from the bismuth phosphate process. Sodium dichromate was added to the nitric acid solvent to oxidize plutonium to a state suitable for organic extraction.

Aluminum nitrate was added to the acid solution as a salting agent for the first extraction column. This salting agent caused the uranium and plutonium to be preferentially extracted by MIBK, leaving the fission products in the aqueous phase. In a second extraction column, a reducing agent was added to the aqueous phase to reduce the plutonium so that it would be removed from the uranium and extracted into the aqueous phase. The organic uranium solution and the aqueous-plutonium solution were then processed separately.

purified further, and concentrated into their respective products; uranium nitrate hexahydrate (UNH) and plutonium nitrate. The plutonium nitrate was sent to the Z Plant for processing into plutonium oxide or plutonium metal. The UNH was sent to the uranium oxide plant.

The organic solvent was treated for recycling by removing decomposition products and by further decontamination. Aqueous streams were concentrated, then the aluminum nitrate was converted to sodium aluminate by sodium hydroxide before disposal.

T Plant. The T Plant was one of the original bismuth phosphate fuels-separation facilities; it was constructed from June 1943 to October 1944 and operated for the bismuth phosphate process from 1944 to 1956. Since 1956, facilities in the T Plant have been used for decontamination and equipment repair.

Z Plant. Constructed in 1949, the Z Plant was the site of the plutonium Laboratory and finishing operations, including the processing of plutonium scrap materials and preparation of plutonium products. The plutonium parts preparation ceased in December 1965. A process known as "recouplex" was operated at the plant from 1955 to 1962 to recover plutonium from scrap and produce a plutonium nitrate solution. The Plutonium Reclamation Facility began operations in 1964 to perform the functions of the recouplex process.

The recouplex process used nitric acid and hydrofluoric acid to dissolve solids and a tributyl phosphate-carbon tetrachloride solvent extraction process for recovery of purified plutonium nitrate solutions. Aluminum nitrate was used to salt the aqueous streams for selective extraction of plutonium and to create complexed fluoride ions as aluminum fluoroxide nitrate to prevent their interference during plutonium extraction. Americium was also recovered in the Plutonium Reprocessing Facility using dibutyl butyl phosphonate (DBBP) in a carbon tetrachloride diluent. The DBBP has subsequently been replaced with tributyl phosphate.

The Plutonium Processing Facility converts plutonium nitrate to plutonium oxide and then to plutonium metal, if metal is the desired product. The plutonium oxide is made by precipitating the plutonium as plutonium oxalate and then calcining the precipitate. To produce metal, the plutonium oxide is first converted to plutonium fluoride. The fluoride is placed in an iron can, which is placed in a magnesium oxide crucible with calcium metal. A reducing charge is applied to the crucible to reduce the plutonium fluoride to plutonium metal, which is then molded into a button. The remaining iron, calcium, and magnesium are dissolved in nitric acid for disposal.

Reference 1, pages 2.15-2.23, Reference 21, pages 449-462.

1/12/88
KID

5 TARGETS

Surface Water Use

Use(s) of surface water within 3 miles downstream of the hazardous substance:

Surface water within the distance of the furthest point of contamination (i.e., the Richland water intake) is used as a source of drinking water, a source of crop irrigation water, a water source at the Ringold fish hatchery, and for recreation (boating, swimming, and fishing). The surface water within three miles downstream is used for recreation. The City of Richland draws water from the river for their drinking water. The 300 Area also withdraws drinking water from the river. There are river water intakes at Ringold Flats, Taylor Flats, Battelle Farm Operations and the Tri-Cities University Center (TUC) where the water is used to irrigate forage and food crops. Part of the water used to rear steelhead trout at the Ringold hatchery comes from the river. Because this reach of the Columbia River are part of the upstream migration route of several salmon species and steelhead trout, this reach is a popular spot for fishing.

Reference 2, pg. 3.19; Reference 13, pg. II.3-4; Reference 14, pgs. 4.28, 4.10; Reference 15; Reference 16; Reference 17; Reference 18; Reference 32; Reference 33; Reference 34.

1/12/88
KGA

Is there tidal influence?

The site is located upstream of four hydroelectric dams, therefore, no tidal influence is observed in the River at the site.

Reference 2, pg 2.1.

Distance to a Sensitive Environment

Distance to 5-acre (minimum) coastal wetland, if 2 miles or less:

Not applicable.

Distance to 5-acre (minimum) fresh-water wetland, if 1 mile or less:

There is no fresh-water wetland within 1 mile of the defined site boundary.

Reference 15; Reference 16; Reference 17.

Distance to critical habitat of an endangered species or national wildlife refuge, if 1 mile or less:

Although there are several sensitive and threatened species that are residents of Hanford Site (for at least part of the year), no endangered species are known to be residents of the site. Two threatened species, the bald eagle and the ferruginous hawk, are residents of the site (for at least part of the year). Because there are no endangered species (state or federal) that reside at the site, there is no critical habitat to be considered in the ranking of the 200 Area Site.

The draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford, Volume 1, July 1986 listed the Merriam's Shrew as being on the State Endangered Species list. This information was taken from a list published in a preliminary draft of an environmental impact statement, and, since the referenced February 1987 list shows the Merriam's Shrew as only a proposed sensitive species, it is assumed that the previous list taken from the preliminary draft is in error.

Reference 1; Reference 19.

Population Served by Surface Water

Location(s) of water-supply intake(s) within 3 miles (free-flowing bodies) or 1 mile (static water bodies) downstream of the hazardous substance and population served by each intake:

River water is withdrawn at five locations within 3 miles of the farthest point of downstream contamination (i.e., Richland City Water Intake) which is used for drinking water and irrigation. Four of these five are irrigation intakes which are Ringold Flats, Taylor Flats, Battelle Farm Operations and Tri-Cities University Center (TUC). The fifth intake is the Richland City

1/12/88
199

Water Intake which is used for drinking water. The Richland city water system serves a population of 33,578 based on the 1980 census. The Richland city water system also has emergency interties with the City of Kennewick water system and the Hanford 300 Area (which also has an intake from the river located in the 300 Area). The Kennewick population is 34,387 based on 1980 census. The population served by the 300 Area is 3110 Hanford workers. The City of Pasco does not have an emergency intertie with the City of Richland water system. Therefore, the population of Pasco was not considered. The other three intakes are only used for irrigation water.

Reference 2, pg. 3.19; Reference 20; Reference 15; Reference 16; Reference 17; Reference 18; Reference 14, pg. 4.33; Reference 32; Reference 34.

11/12/88
X17

Computation of land area irrigated by above-cited intake(s) and conversion to population (1.5 people per acre):

The acreage of irrigated land at Ringold Flats, Taylor Flats, Battelle Farm Operations and Tri-Cities University Center (TUC) is 330 acres, 270 acres, 168 acres and 160 acres, respectively. Based on the formula of 1.5 people per acre the following calculations are made to determine the population associated with the irrigated land:

Ringold Flats Population = 330 acres x 1.5 people/acre = 495 people

Taylor Flats Population = 270 acres x 1.5 people/acre = 405 people

TUC Population = 160 acres x 1.5 people/acre = 240 people

Battelle Farm Operations = 168 acres x 1.5 people/acre = 252 people

Total Population = 1392 people

Reference 15; Reference 16; Reference 17; Reference 32; Reference 34.

Total population served:

The sum of the population served by the Richland City drinking water system and the irrigated land population is 69,530. This total does not include the 3110 300-Area workers since they would also be counted in the City of Richland and City of Kennewick numbers. This will avoid double counting of populations.

Name/description of nearest of above water intakes:

The nearest water intake with the largest population would be the Richland City Intake. This intake is used for drinking water.

Reference 28; Reference 12, page 3; Reference 29

Distance to above-cited intakes, measured in stream miles.

Contamination has been observed at the City of Richland intake. All other intakes are within the contaminated portions of the river as defined in the observed release; therefore, the distance is zero.

Reference 15; Reference 16.

1/12/88
K92

AIR ROUTE

1 OBSERVED RELEASE

Contaminants detected:

Even though air concentrations of some of the constituents of interest can be detected above background offsite, no air monitoring data were found sufficient for HRS scoring of the Hanford CERCLA sites. These constituents of interest detected above background offsite are present in the routine gaseous effluents from operating facilities at Hanford. Therefore, the air route rating factors were not scored.

Date and location of detection of contaminants:

Not applicable.

Methods used to detect the contaminants:

Not applicable.

Rationale for attributing the contaminants to the site:

Not applicable.

2 WASTE CHARACTERISTICS

Reactivity and Incompatibility

Most reactive compound:

Not applicable.

Most incompatible pair of compounds:

Not applicable.

1/12/88
KIA

Toxicity

Most toxic compound:

Not applicable.

Hazardous Waste Quantity

Total quantity of hazardous waste:

Not applicable.

Basis of estimating and/or computing waste quantity:

Not applicable.

3 TARGETS

Population Within 4-Mile Radius

Circle radius used, give population, and indicate how determined:

0 to 4 mi 0 to 1 mi 0 to 1/2 mi 0 to 1/4 mi

Not applicable.

Distance to a Sensitive Environment

Distance to 5-acre (minimum) coastal wetland, if 2 miles or less:

Not applicable.

Distance to 5-acre (minimum) fresh-water wetland, if 1 mile or less:

Not applicable.

1/12/88
KLA

Distance to critical habitat of an endangered species, if 1 mile or less:

Not applicable.

Land Use

Distance to commercial/industrial area, if 1 mile or less:

Not applicable.

Distance to national or state park, forest, or wildlife reserve, if 2 miles or less:

Not applicable.

Distance to residential area, if 2 miles or less:

Not applicable.

Distance to agricultural land in production within past 5 years, if 1 mile or less:

Not applicable.

Distance to prime agricultural land in production within past 5 years, if 2 miles or less:

Not applicable.

Is a historic or landmark site (National Register or Historic Places and National Natural Landmarks) within the view of the site?

11/12/88
L89

HRS DOCUMENTATION LOG SHEET

SITE NAME U.S. DOE Hanford 200 AreaCITY Benton County STATE WA

IDENTIFICATION NUMBER _____

REFERENCE NUMBER	DESCRIPTION OF THE REFERENCE
1	<u>Draft Phase I Installation Assessment of Inactive Waste-</u>
	<u>Disposal Sites at Hanford, Volume 1</u>
2	<u>Environmental Monitoring at Hanford for 1986, PNL-6120</u>
3	<u>Investigation of Ground-Water-Seepage from the Hanford</u>
	<u>Shoreline of the Columbia River, PNL-5289, November 1984</u>
4	<u>Uncontrolled Hazardous Waste Site Ranking System; A Users</u>
	<u>Manual, 40 CFR 300, Appendix A</u>
5	<u>Handbook of 200 Area Waste Sites, Volume I</u>
	<u>1979 Rockwell Hanford Operations, RHO-CD-673</u>
6	<u>Memo to File from BW Mercer on 8-18-87, Solid Waste Volume</u>
	<u>Estimates for Selected 200 Area Burial Grounds</u>
7	<u>Hanford Wells, PNL-5397, February 1985</u>
8	<u>Ground Water Monitoring at Hanford Site, January-December</u>
	<u>1984, PNL-5408</u>
9	<u>Project Inspection, Log Book Project V-749, 400 Area Water</u>
	<u>Systems Improvements Water Well No. 4</u>
10	<u>Washington State Public Supply System Listing</u>
11	<u>Memo to File from BW Mercer on 8-14-87, Drinking Water Wells</u>
	<u>in Franklin County Within 3 Miles of the 200 Area and Within</u>
	<u>3 Miles of the 300 Area Defined Boundary</u>

1/12/88
KLA870-912-16
94328-028

HRS DOCUMENTATION LOG SHEET

SITE NAME U.S. DOE Hanford 200 Area
 CITY Benton County STATE WA
 IDENTIFICATION NUMBER _____

REFERENCE NUMBER	DESCRIPTION OF THE REFERENCE
12	<u>Hanford Reservation Area Worker Census, BNWL-2298, July 1977</u>
13	<u>Waste Management Operations, Hanford Reservations, ERDA-1538,</u> December 1975
14	<u>Draft Environmental Impact Statement, Disposal of Hanford</u> <u>Defense High-Level, Transuranic and Tank Waste, DOE/EIS-0113,</u> Volume 1
15	U.S.G.S. Map showing 200 Area surroundings
16	U.S.G.S. Maps showing 200 Area surroundings
17	U.S.G.S. Map showing 200 Area surroundings
18	Memo to file from DA Lamar, on 8-18-87, regarding Personal Observations of Columbia River Intakes at Taylor Flats and Ringold Flats
19	Endangered and Threatened Wildlife and Plants, 50 CFR, Part 17, Subpart B, October 86
20	Memo to file from KH Cramer regarding Personal Communications with M Gillum concerning Richland City Well Data, August 6, 87
21	<u>Draft Phase I Installation Assessment of Inactive Waste-</u> <u>Disposal Sites at Hanford, Volume 2 (HISS Database)</u>
22	Hanford Ground Water Database Printouts for Wells of Concern
23	<u>129I, 60Co and 106Ru Measurements on Water Samples From the</u> <u>Hanford Project Environs, BNWL-SA-4478, January 1913</u>

11/2/88
KCA

943218.029

HRS DOCUMENTATION LOG SHEET

SITE NAME U.S. DOE Hanford 200 Area
 CITY Benton County STATE WA
 IDENTIFICATION NUMBER _____

REFERENCE NUMBER	DESCRIPTION OF THE REFERENCE
24	<u>Purification of Uranium by IBMK (Hexone) Extraction,</u> UST-RD-PM-9-80
25	<u>Determination of Tritium in Water Samples,</u> UST-RD-PM-9-80
26	<u>Volatile Organic Analysis, Method 8240,</u> UST-RD-PM-9-80
27	<u>Cyanide, Method 9010,</u> UST-RD-PM-9-80
28	Drawing H-3-53734 (Showing 300 Area River Intake)
29	Memo to file from WS Weygandt concerning Personal Communication with R. B. Hall Regarding the 312 River Water Intake for 300 Area, August 13, 1987
30	Database Printouts of Surface Water Sample Points
31	<u>An Assessment of Aquifer Intercommunication in the B Pond -</u> <u>Gable Mountain Pond Area of the Hanford Site,</u> RHO-RE-ST-12P
32	Memo to file from WS Weygandt regarding Personal Conversation with F Trent concerning TUC irrigation intake, August 12, 1987 including note to file from RD Stenner on October 29, 1987, concerning Crops Grown on the TUC 160 Acres
33	Memo to file regarding recreational use of the Columbia River from DR Sherwood, August 26, 1987
34	Battelle Farm Operations Drawing, RC-486 and RC-1147
35	<u>Data Compilation: Iodine-129 in Hanford Groundwater,</u> WHC-EP-0037

11/12/88
 11/12/88
 11/12/88

9473218.0285

1/12/88
K9A
Revised 2/9/88
K9A

REFERENCE 1

Draft Phase I Installation Assessment of Inactive
Waste-Disposal Sites at Hanford, Volume 1

94328.1282

production reactor still in operation. The reactor is a dual-purpose unit and provides low-pressure steam for the 860 megawatt WNP generating plant nearby. The reactor core's cooling water is recycled after it is passed through a heat exchanger that cools the water and produces the steam used by the WNP generating plant. Fewer than 1,500 people work in this area (Yandon 1977).

The reactor's water treatment plant is an updated version of the treatment systems used at the older reactors. The nonradioactive effluents it treats originate from the secondary side of the cooling-water system. Radioactive waste streams are discharged to cribs. The water from these waste streams eventually discharges to the Columbia River via the ground water. The N Reactor contains some additional alloys and material that were not present in the older reactors. These materials are protected from corrosion and the heat transfer surfaces protected against fouling by suitable water treatment.

2.3.2 200 Areas

In the approximate middle of the Hanford Site, on a plateau about 11 kilometers (7 mi) from the Columbia River, are the two 200 Areas (200-East and 200-West), dedicated to chemical separations and waste management. Irradiated fuel, waste-processing, and waste-storage activities are located in these two areas because they are the most isolated from the Site boundaries and are the farthest from both surface and ground water. The water table in this area is 46 to 91 meters (150 to 300 ft) below the surface.

The 200-Area plateau is a glacial, fluvial gravel bar. A thin surface layer of wind-blown silts and sands covers the well-sorted, coarse sands that comprise the Hanford Formation sediments.

Fewer than 3,000 employees work in the 200 Areas (per shift); slightly more than half are in the 200-West Area (Yandon 1977).

The 200 Areas contain nonradioactive support facilities, including transportation maintenance buildings, service stations, and coal-fired powerhouses (with baghouses for airstream cleanup) for process steam production, steam transmission lines, raw-water treatment plants, water-storage tanks, electrical

maintenance facilities, and subsurface sewage disposal systems. In short, the 200 Areas are almost cities to themselves in that they have most of the utilities necessary to be self supporting.

2.3.2.1 200-East Area Plants

The 200-East Area is a controlled area of approximately 8.4 square kilometers (3.2 sq mi). It is about 10 kilometers (6.2 mi) from the Columbia River and 18 kilometers (11 mi) from the nearest Hanford Site boundary. It is located on a plateau at an elevation of approximately 200 meters (656 ft) above mean sea level (MSL). The surface slopes from southwest to northeast, with a maximum difference in elevation across the Site of about 25 meters (82 ft). Depth to ground water ranges from 47 to 103 meters (155 to 338 ft).

There are no naturally occurring surface-water bodies within the 200-East Area. However, process cooling water and aqueous wastes are discharged to an open ditch that carries the effluents to a large impoundment (B-Pond) located just east of the area. West Lake is a small, natural lake located about 4 kilometers (2.5 mi) north of the area. Gable Mountain Pond, formed as a result of waste-water disposal from the 200 Areas, is about 3 kilometers (1.9 mi) to the north. It will no longer be in use after 1987.

PUREX Plant. The Plutonium URanium EXtraction (PUREX) Plant is the most recently constructed of the irradiated-fuel processing plants. Constructed between April 1953 and October 1955, the PUREX Plant took over fuel-processing operations from the REDuction OXidation (REDOX) Plant. The PUREX Plant was operated from 1956 to 1972; in 1972 it was placed in operational standby mode. Plant operations were resumed in 1983.

At this facility, uranium, plutonium, and neptunium are separated from fission products found in the production reactors' irradiated uranium fuel. The process steps involve fuel-element decladding, uranium metal dissolution, solvent extraction, ion exchange, and product loadout.

Zirconium cladding on fuel elements is removed in an ammonium fluoride-ammonium nitrate (AFAN) solution. Ammonium fluoride reacts with the zirconium, resulting in a soluble zirconium compound. The ammonia and hydrogen evolved during decladding present a potential combustion hazard. Therefore hydrogen is converted to ammonia by reaction with ammonium nitrate

present in the AFAN solution. The dissolver solution is then processed to remove plutonium and uranium that dissolved with the cladding. Gas released from the dissolver is treated to remove iodine in a silver reactor, is acid-adsorbed, and is only then released to the atmosphere. The off-gases are treated with hydrogen peroxide to remove nitrogen oxides before being released to the atmosphere.

Decad fuel elements are dissolved in nitric acid for the solvent extraction processes. An organic solvent is used to separate the uranium, plutonium, and neptunium from associated fission products and from each other. The organic solvent used in a series of extraction and stripping operations is a 30% solution of tributyl phosphate in a normal paraffin hydrocarbon (kerosene) diluent.

The first extraction cycle separates the bulk of the fission products from the plutonium, uranium, and neptunium; the fission products remain in the aqueous phase. The organic phase is sent to the partitioning cycle where the plutonium is partitioned from the uranium and neptunium. The plutonium stream is routed through two additional solvent-extraction cycles for further purification. After purification, the plutonium stream is concentrated. From 1956 to 1972, the concentrated plutonium nitrate solution was sent to the plutonium finishing operations located in the 200-West Area. When the PUREX Plant resumed operations in 1983, an additional facility was added that produced plutonium oxide from the plutonium nitrate.

The other stream from the partition cycle, which bears the neptunium and uranium, is routed to the final uranium cycle where neptunium is separated. The aqueous neptunium stream is sent to the backcycle waste system for concentration and recycling to the solvent-extraction column. The uranium stream is routed to a column that strips the uranium from the organic stream with an aqueous nitric acid solution; concentration of the aqueous solution follows. The uranium product, uranyl nitrate hexahydrate (UNH), is then stored in tanks until it is shipped to the UO_3 plant in the 200-West Area.

A portion of the concentrated neptunium solution from the final uranium cycle is sent to the neptunium recovery and purification cycle. In this

cycle, neptunium is separated from the uranium, plutonium, and the remaining fission products in the neptunium stream. This separation is accomplished by a series of extractions and ion-exchange columns. The plutonium and uranium fractions are recycled to the backcycle waste system and partitioning cycle, respectively.

Supporting process systems include organic solvent decontamination and recovery, nitric acid recovery, and waste concentration and recovery.

B Plant. The B Plant, one of the original fuels-separation facilities, was constructed between August 1943 and February 1945; it was operated until 1952. The plant used the bismuth phosphate process to separate plutonium from irradiated uranium fuel. This process produced a very dilute waste stream that contained the uranium and most of the fission products from the fuel elements. Unlike the PUREX process, the bismuth phosphate process separated plutonium from uranium and fission products by precipitating the plutonium onto a bismuth phosphate carrier.

The uranium fuel elements processed by the bismuth phosphate process were jacketed with aluminum. These jackets were removed in a sodium hydroxide-sodium nitrate (NaOH-NaNO_3) solution, with the NaNO_3 acting as a hydrogen scavenger. Some of the silicon used as a binder in the fuel elements was dissolved during jacket removal. This operation produced sodium silicate, sodium aluminate, and sodium nitrite.

After jacket removal, the fuel elements were dissolved in nitric acid; sulfuric acid was then added to complex the uranium. Complexing of uranium prevented it from being precipitated as uranyl phosphate during later plutonium precipitation. The metal solution was pre-treated with sodium nitrite to oxidize or reduce plutonium to the correct state for precipitation. Bismuth phosphate was then added to the metal solution and the resulting slurry was centrifuged. The solid cake was redissolved in nitric acid for further decontamination of the plutonium.

The decontamination involved several dissolutions and subsequent precipitations of plutonium. Sodium bismuthate and sodium dichromate were used as

oxidizing agents, and sodium nitrite or oxalic acid was used as a reducing agent during the plutonium decontamination. The final plutonium precipitate was washed with ammonium nitrate.

The next process involved transferring the plutonium from the bismuth phosphate carrier to a lanthanum fluoride carrier. Hydrofluoric acid was used to acidify the transfer solution and cause lanthanum fluoride to precipitate, carrying the plutonium with it. Potassium hydroxide was used to change the lanthanum precipitate into a soluble compound; then the precipitate was dissolved in nitric acid.

The plutonium was then reduced using ammonium sulphate and precipitated as a peroxide by the addition of hydrogen peroxide. The plutonium peroxide was dissolved into nitric acid. This solution was concentrated to produce the final plutonium nitrate product, which was originally shipped off site for conversion to plutonium oxide or plutonium metal.

In 1968, the B Plant was converted to a waste-fractionization plant as part of a program to solidify high-level waste. The B Plant now functions to remove cesium and strontium from PUREX current acid waste and from high-level supernatant liquids, as well as sludges from self-boiling liquid waste.

The solids are removed from the current acid waste and treated for strontium removal, and the liquid is treated with phosphotungstic acid to precipitate the cesium. The supernatant liquid is sent to a series of solvent extraction columns, similar to those used at the PUREX Plant, to remove and purify any remaining strontium. The cesium precipitate is redissolved in sodium hydroxide and treated in ion exchange columns for further purification. Liquid from stored waste is treated the same as current acid waste, except that the solids have already separated in the storage tanks. Sludge from the storage tanks and solids from current acid waste are dissolved in an acid solution and sent to the solvent-extraction columns for strontium removal.

Cesium solutions are converted to cesium chloride by the addition of hydrochloric acid. The liquid is evaporated to yield solid cesium chloride. This solid is encapsulated in Hasteloy® cylinders and stored in an underwater storage basin at B Plant.

Strontium is precipitated as strontium fluoride by the addition of sodium fluoride. The strontium fluoride is filtered, dried, and encapsulated in Hasteloy® cylinders. These cylinders, like the cesium cylinders, are stored in an underwater storage basin at B Plant.

Semiworks and Critical Mass Laboratory. The Semiworks was built in 1949 as a pilot plant for the REDOX Process; it was later converted to pilot the PUREX process. The Semiworks originally operated from 1952 to 1957. In 1960, the Semiworks was reactivated and equipped for the processing and loadout of fission products; it then operated as both a production and a process demonstration pilot project for converting the B Plant to a waste-partitioning facility. In 1967, the Semiworks was shut down, and it is now being decontaminated and decommissioned. Chemical processes at this facility were similar to those at the REDOX and PUREX plants.

At the Critical Mass Laboratory, research focuses on the criticality safety of plutonium in various forms and combinations with other elements. The resulting data are used to verify analytical methods that predict criticality safety for plutonium in various fuel cycles.

2.3.2.2 200-West Area Plants

The 200-West Area is a controlled area of approximately 8.2 square kilometers (3.2 sq mi); it is about 8 kilometers (5 mi) from the Columbia River and 11 kilometers (6.8 mi) from the nearest Site boundary. In the early 1980s, it was expanded to the west to add land for future burial grounds. There are no naturally occurring surface water bodies within the 200-West Area; however, process cooling water and aqueous waste are discharged to surface impoundments, creating several artificial ponds within or adjacent to the area.

The water table beneath the 200-West Area lies within the Ringold Formation, which has a relatively high permeability. The water table lies at a depth of 55 to 82 meters (180 to 270 ft).

U Plant. Although the U Plant (constructed between 1943 and 1944) was one of the three original fuels-separation facilities designed to use the bismuth phosphate process, it was never used for that purpose.

913218-0005
6070 8126 46

Uranium was not recovered by the bismuth phosphate extraction of plutonium from irradiated fuel. However, the later-developed REDOX and PUREX processes recovered the uranium, which still had economic value. Following startup of the REDOX Plant, the U Plant was converted to recover the uranium from stored radioactive waste. From 1952 to 1958, stored waste was transferred to the U Plant for uranium recovery. The resultant sludge was dissolved in nitric acid, and then the uranium was extracted using tributyl phosphate in a normal paraffin diluent. This process left the fission products, sulfate, and phosphate ions in the aqueous acid solution. The uranium was then stripped from the organic solvent with nitric acid. This nitric acid solution was concentrated and sent to the uranium oxide process.

Although the uranium recovery processing is no longer going on, the adjacent uranium oxide plant is still operational. This plant received uranyl nitrate solution from the recovery process and from the REDOX Plant and calcined it to uranium trioxide. The uranium oxide plant now processes the product uranium from the PUREX Plant. Nitric acid is recycled to the PUREX process as a by-product of the calcination process. The uranium trioxide is shipped off site for use as nuclear fuel.

REDOX Plant. The REDOX process for fuels separation succeeded the bismuth-phosphate process and preceded the PUREX process. The REDOX Plant was constructed from May 1950 to August 1951; it operated until it was shut down in July 1967. An analytical laboratory near the facility is still operational. This laboratory supports B-Plant operations and performs research and development in support of waste management and environmental control operations. The laboratory also functions as a backup laboratory to the PUREX and Z-Plant analytical laboratories.

The REDOX Plant used a solvent extraction process to separate uranium and plutonium from fission products and each other. Methyl isobutyl ketone (MIBK) was the organic solvent that was used.

The fuel elements were prepared for nitric acid dissolution using the methods from the bismuth phosphate process. Sodium dichromate was added to the nitric acid solvent to oxidize plutonium to a state suitable for organic extraction.

Aluminum nitrate was added to the acid solution as a salting agent for the first extraction column. This salting agent caused the uranium and plutonium to be preferentially extracted by MIBK, leaving the fission products in the aqueous phase. In a second extraction column, a reducing agent was added to the aqueous phase to reduce the plutonium so that it would be removed from the uranium and extracted into the aqueous phase. The organic uranium solution and the aqueous-plutonium solution were then processed separately, purified further, and concentrated into their respective products: uranium nitrate hexahydrate (UNH) and plutonium nitrate. The plutonium nitrate was sent to the Z Plant for processing into plutonium oxide or plutonium metal. The UNH was sent to the uranium oxide plant.

The organic solvent was treated for recycling by removing decomposition products and by further decontamination. Aqueous streams were concentrated, then the aluminum nitrate was converted to sodium aluminate by sodium hydroxide before disposal.

T Plant. The T Plant was one of the original bismuth phosphate fuels-separation facilities; it was constructed from June 1943 to October 1944 and operated for the bismuth phosphate process from 1944 to 1956. Since 1956, facilities in the T Plant have been used for decontamination and equipment repair.

Z Plant. Constructed in 1949, the Z Plant was the site of the plutonium laboratory and finishing operations, including the processing of plutonium scrap materials and preparation of plutonium products. The plutonium parts preparation ceased in December 1965. A process known as "recouplex" was operated at the plant from 1955 to 1962 to recover plutonium from scrap and produce a plutonium nitrate solution. The Plutonium Reclamation Facility began operations in 1964 to perform the functions of the recouplex process.

The recouplex process used nitric acid and hydrofluoric acid to dissolve solids and a tributyl phosphate-carbon tetrachloride solvent extraction process for recovery of purified plutonium nitrate solutions. Aluminum nitrate was used to salt the aqueous streams for selective extraction of plutonium and to create complexed fluoride ions as aluminum fluoroxide nitrate to prevent their interference during plutonium extraction. Americium was also

recovered in the Plutonium Reprocessing Facility using dibutyl butyl phosphonate (DBBP) in a carbon tetrachloride diluent. The DBBP has subsequently been replaced with tributyl phosphate.

The Plutonium Processing Facility converts plutonium nitrate to plutonium oxide and then to plutonium metal, if metal is the desired product. The plutonium oxide is made by precipitating the plutonium as plutonium oxalate and then calcining the precipitate. To produce metal, the plutonium oxide is first converted to plutonium fluoride. The fluoride is placed in an iron can, which is placed in a magnesium oxide crucible with calcium metal. A reducing charge is applied to the crucible to reduce the plutonium fluoride to plutonium metal, which is then molded into a button. The remaining iron, calcium, and magnesium are dissolved in nitric acid for disposal.

2.3.3 300 Area

The 300 Area is located about 1.6 kilometers (1 mi) north of the Richland city limits, on the bank of the Columbia River. Roughly rectangular in shape, the area covers about 1.5 square kilometers (370 acres); waste-management facilities have been added just to the north of the 300 Area.

Occupying a relatively flat area on the west bank of the Columbia River, the area has an elevation that is about 15 meters (50 ft) above the average elevation of the adjacent river. The Hanford Site land surface surrounding the 300 Area is devoid of prominent surface features and slopes gently upward to the northwest.

The surface sediments in the 300 Area are largely wind-transported sands and silts. These sediments, which were deposited in dunes up to about 3 meters (9.8 ft) in depth, have been largely stabilized by vegetation. Below this layer lie 20 to 25 meters (66 to 82 ft) of coarse-grained glaciofluvial deposits known as the Pasco Gravels; the permeability of these deposits is very high.

The high porosity and permeability of the sands and gravels that underlie the area allow any precipitation to infiltrate rapidly. Flooding of any

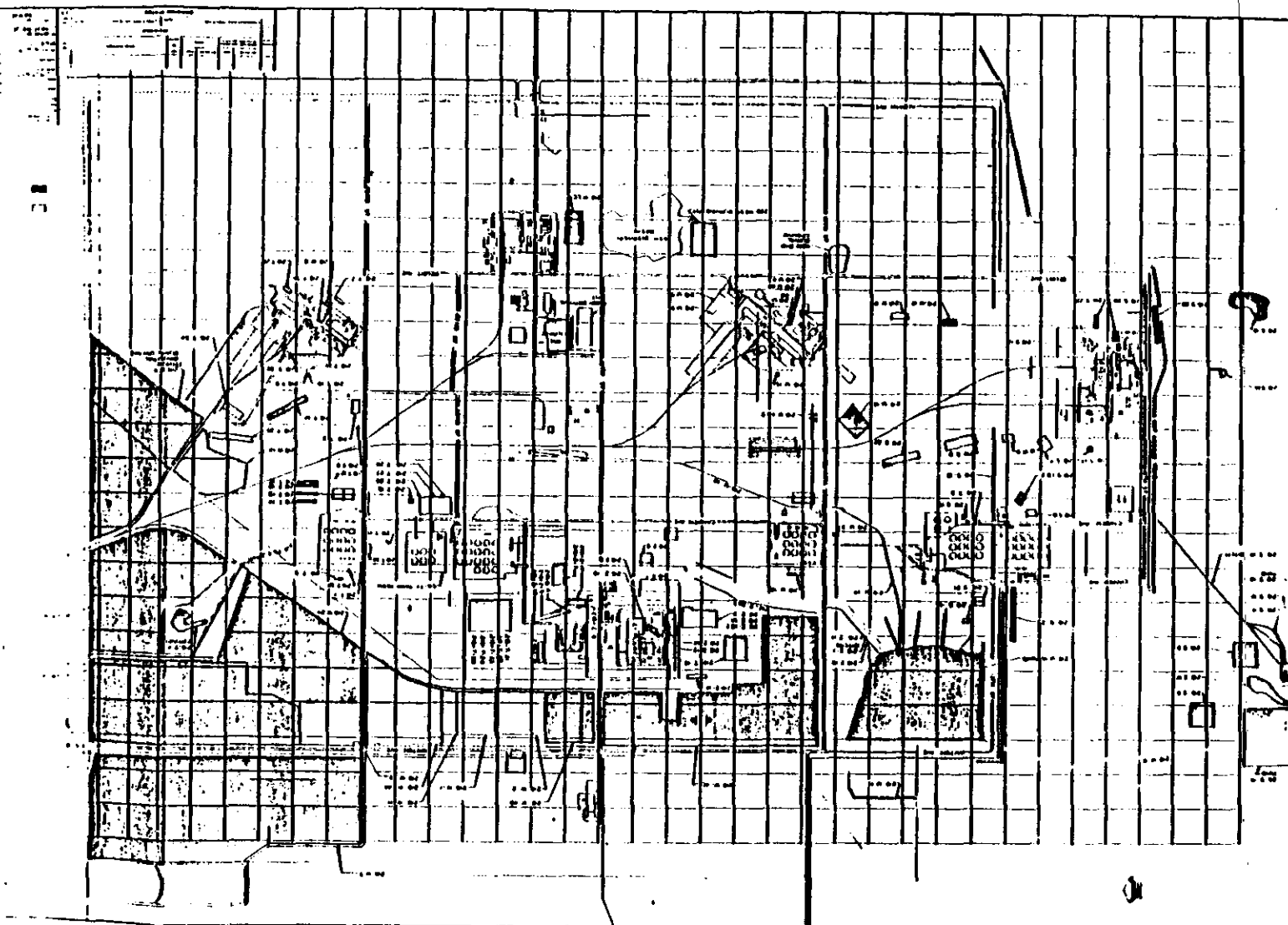
9413218.0292

These general categories were used in conjunction with the mHRS/HRS scores to identify the potentially hazardous liquid-effluent disposal sites in the 200 Areas and to complement the mHRS/HRS score by providing site-specific information not otherwise addressed. For example, a waste may have contained complexants that increased contaminant mobility. Although these complexants were not hazardous chemicals (and thus contributed little to the score), they increased the potential hazard of a disposal facility by mobilizing radioactive contaminants. Conversely, factors such as waste volume and distance to or contact with the ground water, as well as many other parameters that influenced the potential hazard of a facility, were taken into account in the scoring but were not considered in categorizing the sites. The mHRS/HRS scores, in combination with waste characteristics, allowed a more comprehensive evaluation of the potential hazard from past waste-disposal practices. The relative potential hazard from each liquid-effluent disposal site will be described on a plant-by-plant basis for the 200-East and 200-West Areas in Section 3.3.

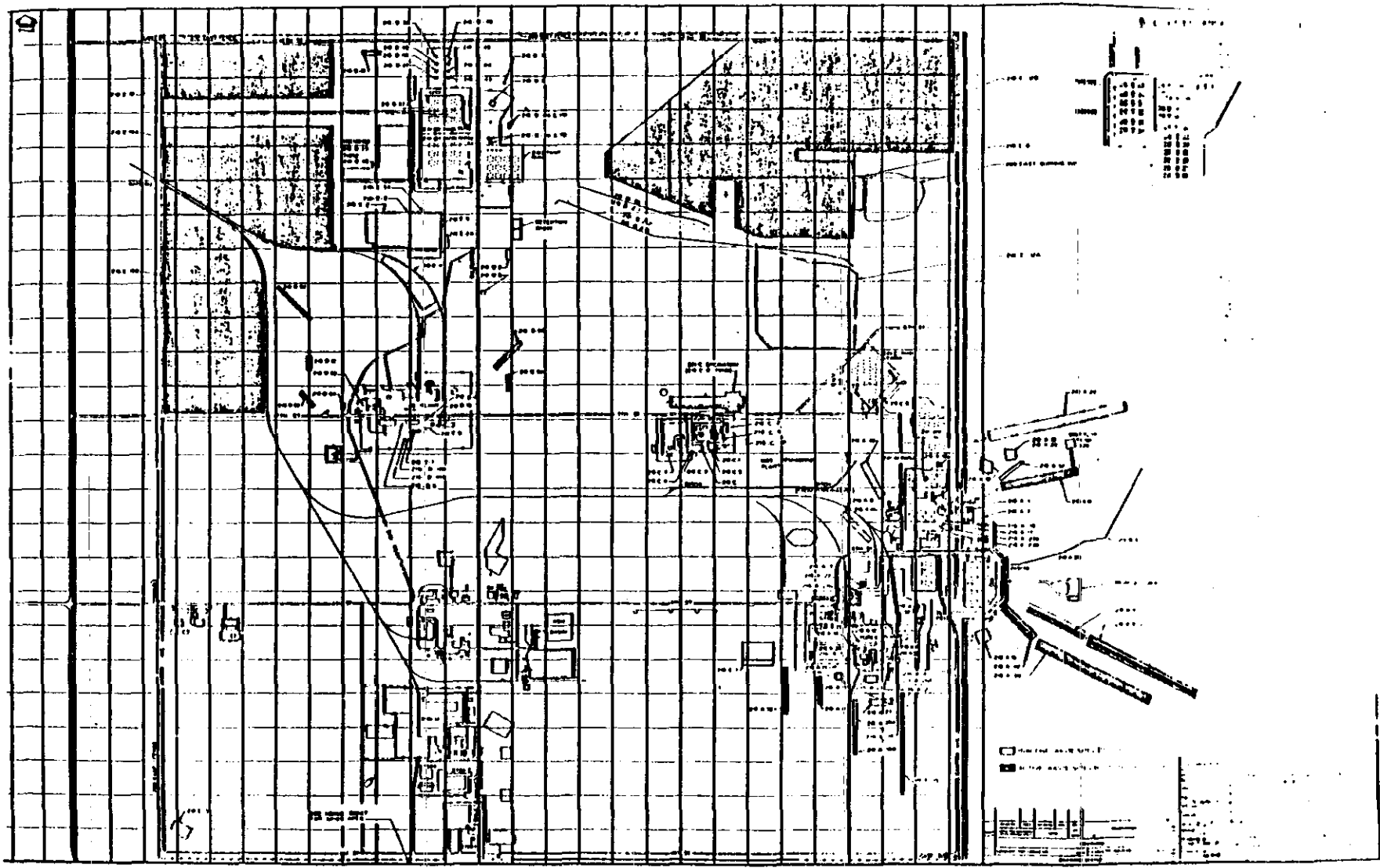
Steam condensate and cooling water are primarily river water with little potential for chemical or radioactive contamination. These liquid effluents made up a large portion of the water used in the 200 Areas. Steam condensate and cooling water were most commonly discharged through unlined ditches to ponds for evaporation or drainage to the ground water. Accidental releases of radioactive and hazardous substances to these facilities have occurred, but represent only a small fraction of the waste volume discharged to these sites. Sites that received steam condensate and cooling water are not considered to represent a priority for Phase II characterization, but for those sites that scored more than 28.5, "further action pending" is recommended.

Process condensate is that water condensed from closed systems that has been in direct contact with radioactive material. Process condensate can be acidic or alkaline and often contains relatively low concentrations of nitrate, ammonia, and possibly volatile organic compounds. It is likely that certain of these process condensates also contain potentially volatile radionuclides. Carbon-14, tritium, iodine-129, ruthenium-106, and other radionuclides could be contained in process condensates. Because of their

9 32 0 23



9443218.0294



0.15

Ref. 1.12

REFERENCE 2

Environmental Monitoring at Hanford for 1986, PNL-6120

9132000000

2.0. BACKGROUND INFORMATION

2.1. DESCRIPTION OF THE HANFORD SITE

K. R. Price, P. J. Mitchell, and M. D. Freshley

The U.S. Department of Energy's Hanford Site is located in a rural region of southeastern Washington and occupies an area of 1,500 km². The Site (shown in Figure 2.1) lies about 320 km northeast of Portland, Oregon, 270 km southeast of Seattle, Washington, and 200 km southwest of Spokane, Washington. The Columbia River flows through the northern edge of the Hanford Site and forms part of the eastern boundary. The southern boundary of the Site includes the Rattlesnake Hills, which exceed 1000 m in elevation. Both confined and unconfined aquifers are present beneath the Site. The main geologic units are the Columbia River Basalt Group, the Ringold Formation, and a series of glaciofluvial sediments. The Hanford Project was established in 1943 and was originally designed, built, and operated to produce plutonium for nuclear weapons.

SURFACE CHARACTERISTICS OF THE SITE

The semiarid land on which the Hanford Site is located has a sparse covering of desert shrubs and drought-resistant grasses. The most broadly distributed type of vegetation on the Site is the sagebrush/cheatgrass/bluegrass community. Most abundant of the mammals is the Great Basin pocket mouse. Of the big-game animals, the mule deer is the most abundant, while the cottontail rabbit is the most abundant of the small-game animals. Coyotes are also abundant. The bald eagle is a regular winter visitor to the relatively large areas of uninhabited land comprising the Hanford Site.

The Columbia River, which originates in the mountains of eastern British Columbia, Canada, flows through the northern edge of the Hanford Site and forms part of the Hanford Site's eastern boundary. The river drains a total area of approximately 70,800 km² enroute to the Pacific Ocean. The flow of the Columbia River is regulated by 11 dams within the United States, 7 upstream and 4 downstream of the Site. Priest Rapids Dam is the nearest impoundment upstream of the Site, and McNary Dam is the nearest dam downstream. (The Hanford reach of the Columbia River extends from Priest Rapids Dam to the head of Lake Wallula, which is created by McNary Dam.) This is the only stretch of the Columbia River within the U.S. that is not impounded by a dam. The width of the river

varies from approximately 300 m to about 1000 m. The flow through this stretch of the river is relatively swift, with numerous bends and several islands present throughout the reach.

The flow rate of the Columbia River in this region is regulated primarily by Priest Rapids Dam. Hanford reach flows fluctuate significantly because of the relatively small storage capacity and operational practices of the nearby upstream dams. A minimum flow rate of 1,000 cubic meters per second (m³/s) [36,000 cubic feet per second (cfs)] has been established at Priest Rapids. Typical daily flows range from 1,000 m³/s (36,000 cfs) to 7,000 m³/s (250,000 cfs) with peak spring runoff flows of up to 12,600 m³/s (450,000 cfs) being recorded. Typical annual average flows at Priest Rapids Dam are 3,100 m³/s (110,000 cfs) to 3,400 m³/s (120,000 cfs). Monthly mean flows typically peak from April through June and are at the lowest levels from September through October.

The temperature of the Columbia River varies seasonally. Minimum temperatures are observed during January and February while maximum temperatures typically occur during August and September. Monthly temperatures for the river range from approximately 3°C to about 20°C during the course of a year. Water storage management practices at upstream dams and the flow rate of the river dictate, to a large extent, the thermal characteristics of the Columbia River along the Hanford reach.

943218.0298

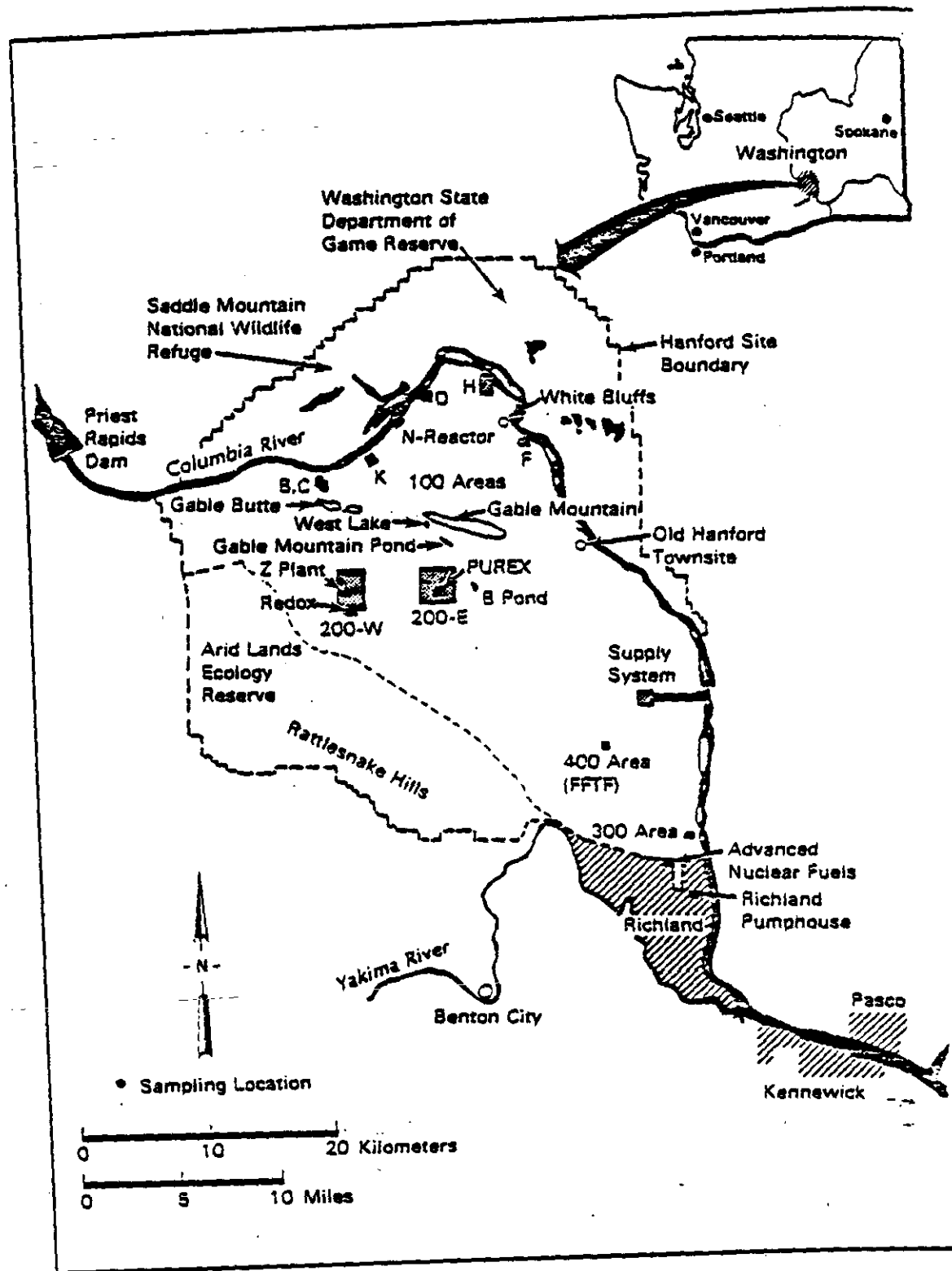


FIGURE 2.1. DOE's Hanford Site

6601912616

The Columbia River system has been developed extensively for hydroelectric power, flood control, navigation, irrigation, and municipal and industrial water supplies. In addition, the Hanford reach is used for a variety of recreational activities including fishing, hunting, boating, water skiing, and swimming. The State of Washington has classified the stretch of the Columbia River from the Washington-Oregon border to Grand Coulee Dam (which includes the Hanford reach) as Class A and established water quality criteria and water use guidelines for this class designation. Because these criteria do not include specific limits for radionuclides, Environmental Protection Agency (EPA) and State of Washington drinking water limits were used for comparison. Other surface water on the Site consists of West Lake (a small, natural pond) and a number of ditches and artificial ponds created for routine disposal of waste water.

Hanford's climate is dry and mild; the area receives approximately 16 cm of precipitation annually. About 40% of the total precipitation occurs during November, December, and January, only 10% falls in July, August, and September. Approximately 45% of all precipitation from December through February is snow. The average minimum and maximum temperatures in July are 16°C and 32°C. For January, the average temperatures are 3°C and -6°C.

Density average wind speeds range from about 12 km/h in the summer to 14 km/h in the winter. The prevailing regional winds are from the northwest, with occasional cold-air drainage into valleys and occurrences of strong crosswinds. The region is a typical desert area with frequent strong inversions that occur at night and break during the day, resulting in unstable and turbulent wind conditions.

Land near the Hanford Site is primarily used for agriculture and for livestock grazing. Agricultural lands are found north and east of the Columbia River and south of the Yakima River. These areas contain orchards, vineyards, and fields of wheat, and vegetables. The Hanford Site north of the Columbia River is shared between a state wildlife management area and a federal wildlife refuge. The northeast slope of the Rattlesnake Mountains along the southwestern boundary of the Site is designated as the Arid Lands Ecology Reserve (ALE) and is used for ecological research by DOE.

The major population center nearest to the Hanford Site is the Tri-Cities area (Richland, Pasco, and Kennewick), which is situated on the Columbia River downstream from the Site and has a population of approximately 90,000. Approximately 340,000 people live within an 80-km radius of the Hanford Site. This number includes people living in the Tri-Cities, the Yakima area, several small communities, and the surrounding agricultural area. More detail on Site characteristics and activities is available in "The Final Environmental Statement, Waste Management Operations, Hanford Reservation" (ERDA 1975).

SUBSURFACE CHARACTERISTICS OF THE SITE

The DOE operations on the Site have resulted in the production of large volumes of waste water that have historically been discharged to the ground through cribs, ditches, and ponds. These discharges greatly influence the physics and chemistry of the subsurface. Approximately 25 billion liters of liquid effluent in the 200 Areas and 2.6 billion liters of liquid effluent in the 100N Area were disposed to the ground during 1986, including process cooling water and water containing low-level radioactive wastes. The discharge of waste water to the ground at the Hanford Site began in the mid-forties and reached a peak in 1955. After 1955, discharge to cribs declined because of improved treatment of waste streams and the deactivation of various facilities (Graham et al. 1981). Since the restart of the Plutonium and Uranium Extraction (PUREX) Plant and related facilities in late 1983, discharge of PUREX-related effluents has resumed.

Subsurface structures, such as cribs, have primarily been used for the disposal of water containing radioactive wastes, while surface ponds and ditches have primarily been used for the disposal of uncontaminated cooling water (Graham et al. 1981). Sanitary wastes are discharged to the ground via tile fields. The majority of liquid disposal occurred in the Separations Area, which includes the 200-East (200E) and 200-West (200W) Areas (Figure 2.1). Smaller amounts of waste water were disposed in the 100 and 300 Areas. Discharges of waste water to the ground in the 400 Area were minimal.

Geologic and hydrologic properties of the sub-surface, including stratigraphy and physical and chemical properties of the host rock, influence the movement of the liquid effluents. The geology and hydrology beneath the Site and the physical nature of liquid effluent movement are described in more detail in the following sections.

Geology

The main geologic units beneath the Hanford Site include, in ascending order, the Columbia River Basalt Group, the Ringold Formation, and a series of glacioluvial sediments informally known as the Hanford formation. A generalized geologic cross section of the Site is shown in Figure 2.2.

The Columbia River Basalt Group is a thick series of basalt flows. The basalts have been warped and folded, producing anticlines that, in some places, crop out at the land surface. The Ringold Formation overlies the basalts except in some localized areas. This formation consists of fluvial and lacustrine sediments and is separated into four lithologic units: basal, lower, middle, and upper. The basal and middle units consist mostly of semiconsolidated gravels and sands whereas the lower and upper units consist mainly of bedded silts and sands. Beneath the 200-West Area, sediments of the upper Ringold Formation have been reworked by the wind and deposited as a silt layer called the Palouse soil. The Hanford formation rests atop the Ringold Formation or Palouse soil. The Hanford formation also rests atop basalts in places where

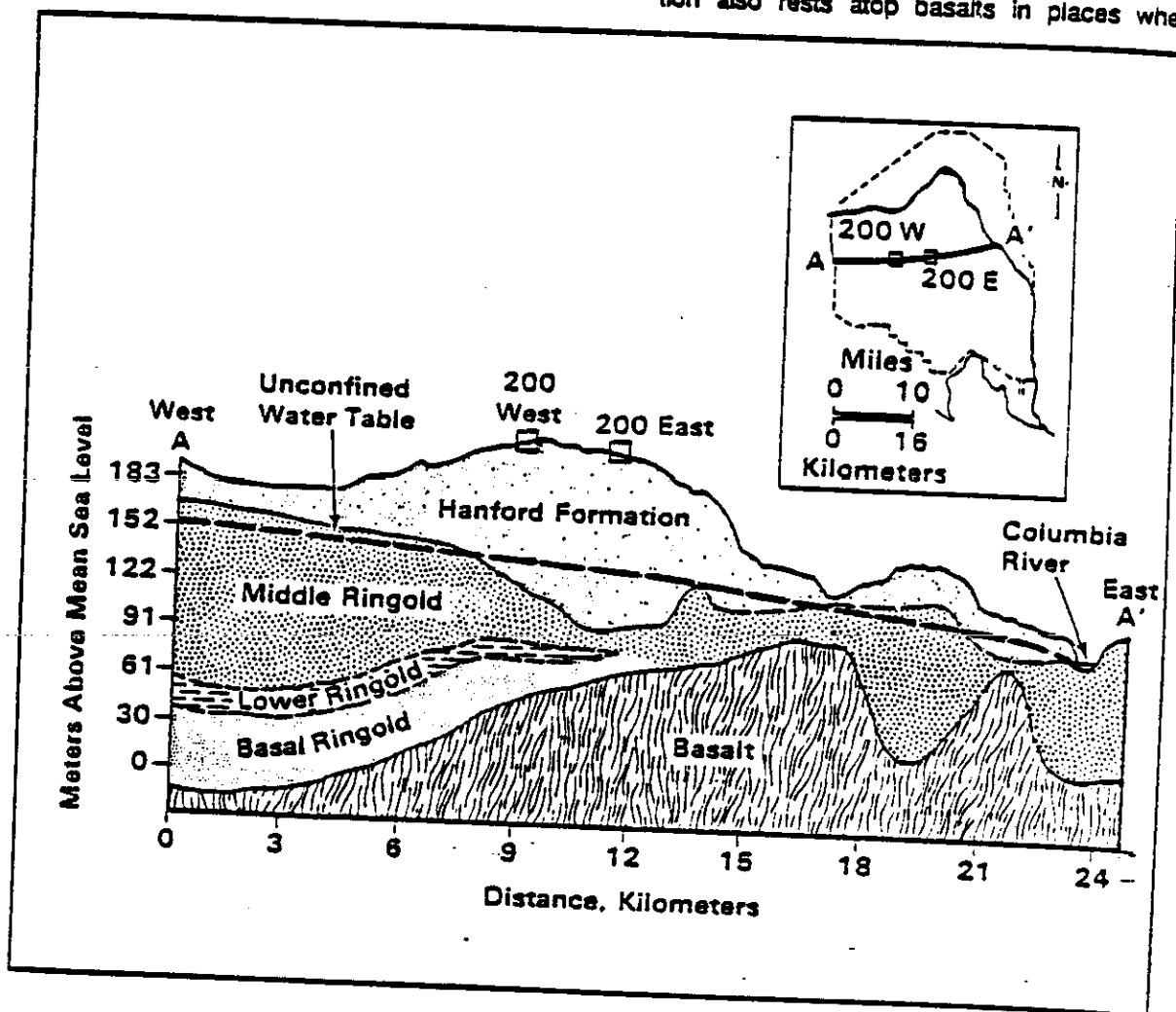


FIGURE 2.2. Geologic Cross Section of the Site (modified from Tailman et al. 1979)

the Ringold formation has been removed. These sediments were deposited by the ancestral Columbia River when it was swollen by glacial meltwater. The glaciofluvial sediments consist primarily of gravels and sands, with some silts (Newcomb, Strand and Frank 1972).

Hydrology

Both confined and unconfined aquifers are present beneath the Hanford Site. The confined aquifers, in which the ground water is under pressure greater than that of the atmosphere, are found primarily within the Columbia River basalts. In general, the unconfined or water-table aquifer is located in the Ringold Formation and glaciofluvial sediments, as well as some more recent alluvial sediments in areas adjacent to the Columbia River (Gephart et al. 1979). This relatively shallow aquifer has been affected by waste-water disposal at Hanford more than the confined aquifers (Graham et al. 1981). Therefore, the unconfined aquifer is the most thoroughly monitored aquifer beneath the Site.

The unconfined aquifer is bounded below by either the basalt surface or, in places, the relatively impervious clays and silts of the lower unit of the Ringold Formation. Laterally, the unconfined aquifer is bounded by the anticlinal basalt ridges that ring the basin and by the Yakima and Columbia rivers. The basalt ridges above the water table have a low permeability and act as a barrier to lateral flow of the ground water (Gephart et al. 1979). The saturated thickness of the unconfined aquifer is greater than 61 m in some areas of the Hanford Site and pinches out along the flanks of the basalt anticlines. The depth from the ground surface to the water table ranges from less than 0.3 m near the Columbia River to over 106 m in the center of the Site. The elevation of the water table above mean sea level for June of 1986 is shown in Figure 2.3.

Recharge to the unconfined aquifer originates from several sources (Graham et al. 1981). Natural recharge occurs from precipitation at higher elevations and runoff from ephemeral streams to the west, such as Cold Creek and Dry Creek. The Yakima River recharges the unconfined aquifer as it flows along the southwest boundary of the Hanford Site. The Columbia River recharges the unconfined aquifer during high flows when river water is transferred to the aquifer along the river bank. The unconfined aquifer receives little, if any, recharge from pre-

cipitation directly on the Hanford Site because of a high rate of evapotranspiration under native soil and vegetation conditions. However, present studies, such as those described by Heller, Gee, and Meyers (1985), suggest that precipitation may contribute more recharge to the ground water than was originally thought.

Large scale artificial recharge occurs from offsite agricultural irrigation and liquid-waste disposal in the operating areas at Hanford. Recharge from irrigation in the Cold Creek Valley enters the Hanford Site as ground-water flow across the western boundary. Artificial recharge from waste-water disposal at Hanford occurs principally in the Separations Area. It was estimated that recharge to the ground water from facilities in the Separations Area (including B Pond and Gable Mountain Pond, as well as the various cribs and trenches in the 200W and 200E Areas) adds ten times as great an annual volume of water to the unconfined aquifer as is contributed by natural inflow to the area from precipitation and irrigation waters to the west (Graham et al. 1981).

The operational discharge of water has created ground-water mounds near each of the major waste-water disposal facilities in the Separations Area and in the 100 and 300 Areas (Figure 2.3). These mounds have altered the local flow pattern in the aquifer, which is generally from the recharge areas in the west to the discharge areas (primarily the Columbia River) in the east. Water levels in the unconfined aquifer have changed continuously during Site operations because of variations in the volume of waste water discharged. Consequently, the movement of ground water and its associated constituents has also changed with time.

In addition to the Separations Area, ground-water mounding also occurs in the 100 and 300 Areas. Ground-water mounding in these areas is not as significant as in the Separations Area because of differences in discharge volumes and subsurface geology. However, in the 100 and 300 Areas, water levels are also greatly influenced by river stage.

Liquid Effluent Movement

If significant quantities of liquid effluents are discharged to the ground at the Hanford Site waste disposal facilities, then these effluents would percolate downward through the unsaturated zone to the water table. As

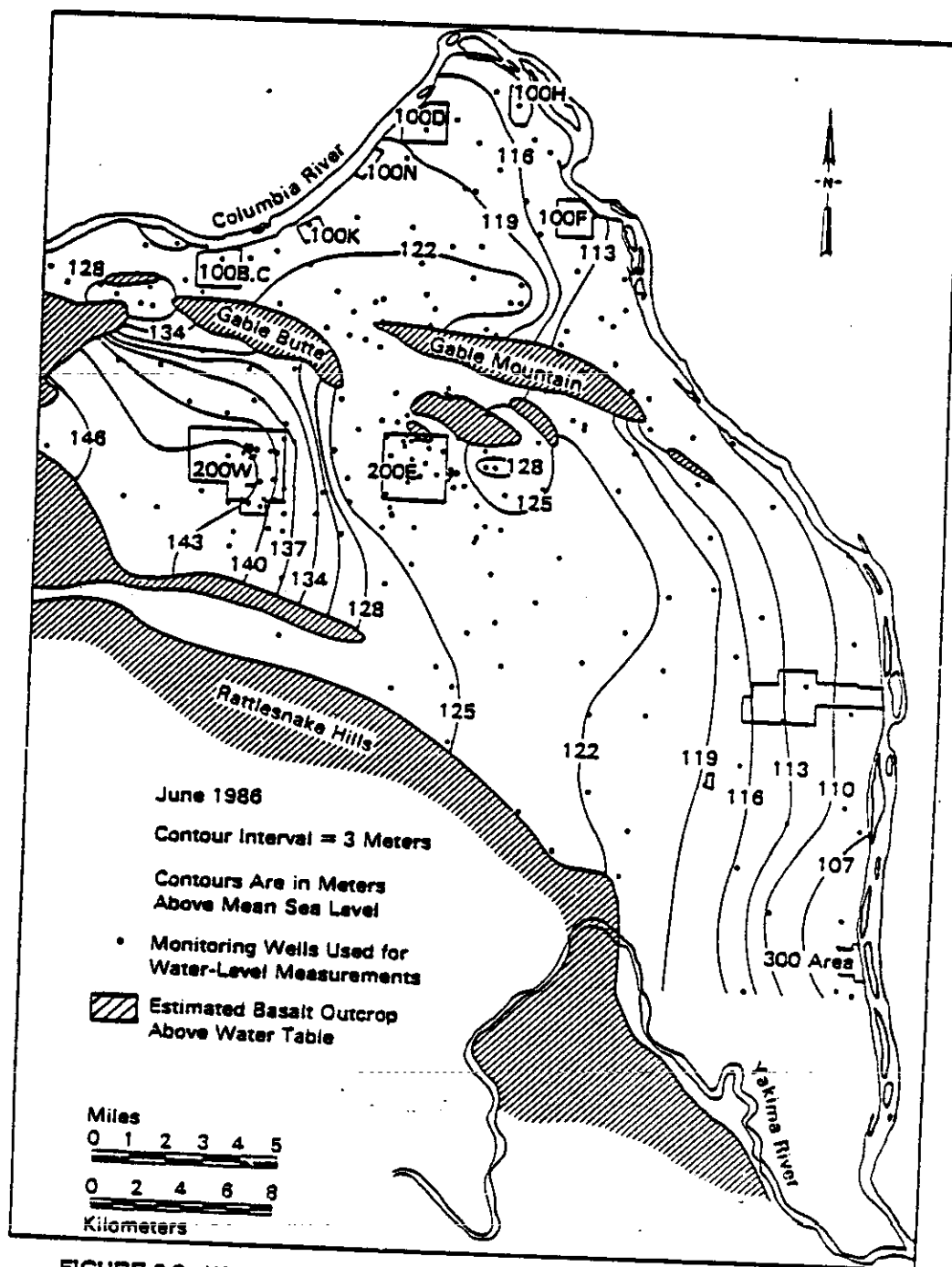


FIGURE 2.3. Water Table Elevations for June 1986 (Schatz and Jensen 1986)

effluents move through the unsaturated zone, adsorption onto soil particles, chemical precipitation, and ion exchange delays the movement of some uncomplexed radionuclides, such as ^{90}Sr , ^{137}Cs , and $^{239,240}\text{Pu}$. Other ions, such as nitrate (NO_3), and radionuclides, such as ^3H , ^{129}I , and ^{99}Tc , are not retained by the soil as readily. These constituents move through the soil column at varying rates and eventually enter the ground water. Subsequently, the nonattenuated constituents move downgradient in the same direction as and at a rate nearly or often equal to the flow of ground water. As the constituents move with the ground water, radionuclide concentrations are reduced by spreading (dispersion) and radioactive decay.

MAJOR ACTIVITIES

Previously, the Hanford Site housed and operated up to nine production reactors, including eight with once-through cooling by treated river water. Between December 1964 and January 1971, all eight reactors with once-through cooling were deactivated. The N Reactor, which is the production reactor remaining in operation, has a closed primary cooling loop.

Four major DOE operating areas exist at the Hanford Site [i.e., 100, 200, 300, and 400 Areas (Figure 2.1)]. The 100 Areas include facilities for the N Reactor and the eight deactivated production reactors along the Columbia River. The reactor fuel reprocessing plant (PUREX), Plutonium Finishing Plant (Z Plant), and waste management facilities are on a plateau about 11.3 km from the river, in the 200 Areas. The 300 Area, just north of the city of Richland, contains the reactor fuel manufacturing facilities and research and development laboratories. The Fast Flux Test Facility (FFTF) is located in the 400 Area, approximately 8.8 km northwest of the 300 Area.

Privately owned facilities located within the Hanford Site boundaries include the Washington Public Power Supply System (Supply System) generating station adjacent to the N Reactor, the Supply System power reactor and office buildings, and a low-level radioactive-waste burial site operated by U.S. Ecology. The Advanced Fuel Corp. (formerly Exxon) fuel fabrication facility is immediately adjacent to the Hanford Site.

Principal DOE operating contractors at Hanford during 1986 included the following:

Rockwell Hanford Operations (Rockwell) – responsible for fuel reprocessing, waste management, and Site support services, such as plant security, fire protection, central stores, and electrical power distribution.

Battelle Memorial Institute (BMI) – responsible for operating PNL for DOE. Pacific Northwest Laboratory activities include research and development in the physical, life, and environmental sciences; chemistry; and advanced methods of nuclear waste management. Pacific Northwest Laboratory is also responsible for environmental monitoring at the Site.

UNC Nuclear Industries (UNC) – responsible for fabricating N Reactor fuel, operating the N Reactor, and decommissioning formerly used DOE facilities, including deactivated production reactors.

Westinghouse Hanford Company (WHC) – responsible for operating the Hanford Engineering Development Laboratory (HEDL), including advanced reactor developments and the FFTF test reactor.

Hanford Environmental Health Foundation (HEHF) – responsible for occupational medicine and environmental health support services.

Operational Highlights

Highlights of operational activities at Hanford during 1986 were

- The N Reactor operated for 182 days, during which time it supplied steam used by the Supply System to generate 860 megawatts of electrical power. Since its startup, the N Reactor has supplied steam for the production of over 65 billion kilowatt-hours of electrical power, which has been supplied to the Bonneville Power Administration grid covering the Pacific Northwest.
- The PUREX Plant fuel reprocessing facility located in the 200E Area completed a third year of operation since restart of operations in 1983. The uranium oxide plant (UO_3 Plant) operated as needed through 1986. The Plutonium Reclamation Facility at Z Plant operated throughout the year as well.

200 Area Background *BK* and Down gradient (*DG*) Wells

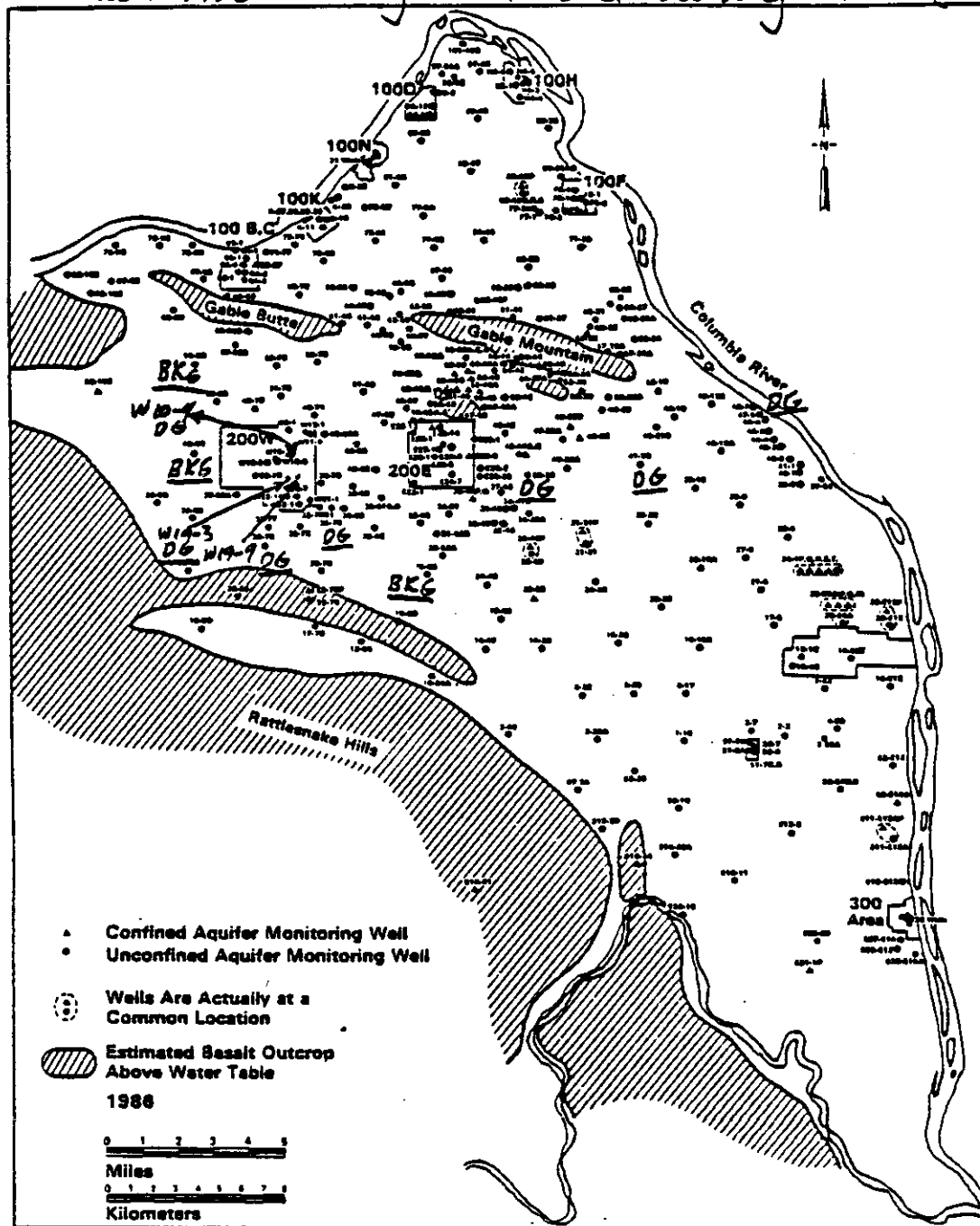


FIGURE 3.10. Location of Ground-Water Monitoring Wells Sampled in 1986 (first digit of well number has been dropped)

collection, in accordance with documented procedures. Further details on analyses are found in Appendix D and in the "Quality Assurance" section.

RADIOLOGICAL MONITORING RESULTS FOR THE UNCONFINED AQUIFER

Ground-water monitoring for certain radiological constituents at the Hanford Site was based on past and/or present waste management practices. Table 3.6 identifies major constituents associated with Site operations. Radiological monitoring results for tritium, gross alpha, gross beta, ^{60}Co , ^{137}Cs , ^{106}Ru , ^{125}Sb , ^{131}I , ^{129}I , uranium (total and isotopic), and strontium isotopes are discussed below. (Nitrate and Cr results are discussed in this section in "Chemical Monitoring Results for the Unconfined Aquifer.")

Past monitoring results have shown that tritium is present in ground water; it also appears to be the most mobile radionuclide at the Site. As a result, tritium reflects the extent of contamination in the ground water from Site operations. Figure 3.12 illustrates the 1986 distribution of average tritium concentrations in the unconfined aquifer, resulting from 40 years of Site operations. Contours of tritium concentrations shown in Figure 3.12 were drawn based on the analysis of ground-water samples collected from monitoring wells. For each well, an average value of up to 12 tritium measurements was used. (The contour level of 5000 pCi/L serves to delineate tritium concentrations above background levels; this contour was not used in previous reports.) A summary of tritium concentrations in wells sampled during 1986 is presented in Appendix A, Table A.12.

Tritium plumes in the 100 Areas are the result of liquid waste disposal during past and present reactor operations. During 1986, tritium concentrations exceeded the DWS (20,000 pCi/L) beneath isolated portions of the 100B, 100F, 100K, and 100N Areas. Tritium distributions beneath the 100B and 100F Areas appeared to have stabilized or diminished slightly from 1985 to 1986. The highest tritium concentration within the 100 Areas was observed in well 1-K-30 (see Figure 3.10 for location). The average tritium concentration in that well increased from 420,000 pCi/L in 1985 to about 640,000 pCi/L

in 1986. However, this increase remained within the range of concentrations measured since 1981 (470,000 to 880,000 pCi/L). No other wells within the 100K Area had concentrations in this range, although tritium concentrations above background levels appeared in well 1-K-29 (averaging 27,000 pCi/L) during 1986. Tritium concentrations in wells surrounding the 100N Area remained relatively stable during the past year. The range of average yearly tritium concentrations in the immediate vicinity of the 100N Area liquid disposal facilities was about 30,000 to 110,000 pCi/L. The tritium distribution beneath the 100N Area changed because liquid effluent disposal to the 1301N Liquid Waste Disposal Facility (LWDF) was discontinued and the 1325N LWDF, which is farther from the Columbia River than the 1301N LWDF, was activated. All concentrations observed in the 100 Areas were significantly lower than the DCG (2,000,000 pCi/L) for tritium.

Several tritium plumes emanated from the 200 Areas. The distribution of tritium beneath the 200E and 200W Areas is the result of disposal of liquids used in chemical processing activities. The potential sources of these tritium plumes were identified by comparing data on each of the plumes with data presented in the Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford(a). This comparison suggested that process condensate liquid wastes from the PUREX Plant (in the 200W Area) and from past operations at the REDOX Plant (in the 200W Area) represent the major sources of tritium. (Process condensate is water that is condensed from closed systems that are in direct contact with radioactive material.) At both the PUREX and REDOX plants, process condensates resulted from the initial dissolution of the nuclear fuel. A widespread plume situated between the 200E Area and the Columbia River (Figure 3.12) is primarily a result of operations at the PUREX Plant during 1956 to 1972. The historical movement of tritium along ground-water flow paths from PUREX to the Columbia River was also observed at individual monitoring wells. The tritium concentration history at well 6-41-23 (Figure 3.13), located midway between

(a) U. S. Department of Energy, 1986, Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford, Richland, Washington.

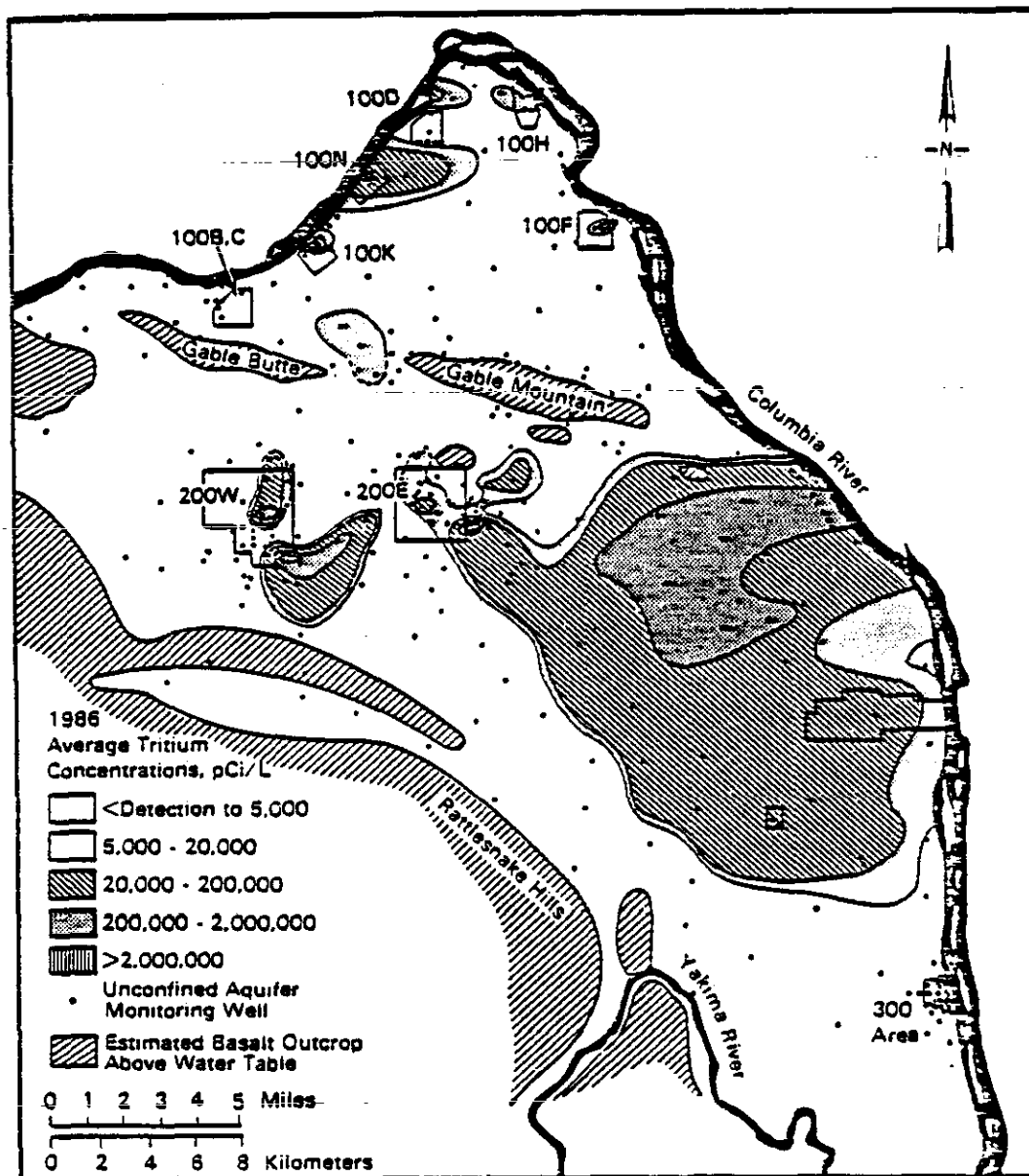


FIGURE 3.12. Tritium Concentrations in Ground Water for 1986

TABLE 3.6. Major Constituents Linked to Site Operation Activities

Facilities Type	Area	Constituents
Reactor Operations	100	Tritium, ^{60}Co , ^{90}Sr , Cr
Irradiated Fuel Processing	200	Tritium, nitrate, ^{137}Cs , ^{129}I
Fuel Fabrication	300	Uranium, Cr

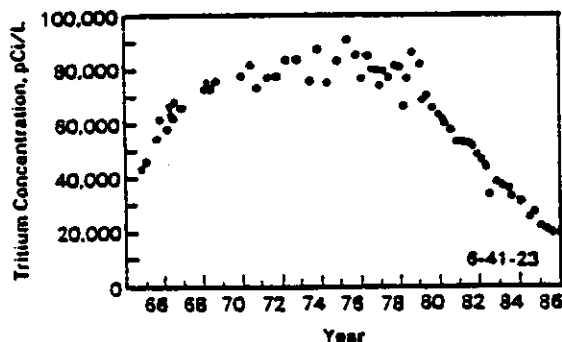


FIGURE 3.13. Tritium Concentrations in Well 6-41-23, 1966 Through 1986

the 200E Area and the Columbia River (Figure 3.10), showed increases (until about 1977) and decreases (from 1977 to the present) in concentrations as tritium flowed past the well. The decrease in concentrations at this well resulted from the discontinuation of PUREX operations in 1972, when ground water with a lower tritium concentration began flowing past the well. Tritium concentration histories at three other locations [wells 6-40-1 and 6-42-2 near the Columbia River (Figure 3.14) and well 6-42-12A located farther inland (Figure 3.15)] also showed increases in tritium during the 1970s. Concentrations have not yet begun to decrease at these wells as shown by their location in the plume (within the contour of 200,000 pCi/L; see Figure 3.12). It is expected that concentrations in these three wells will decrease (as they have in well 6-41-23) when the cleaner ground water reaches the wells. The variations in concentrations at wells 6-40-1 and 6-42-2 can be partially attributed to the mixing of surface water in the aquifer as the Columbia River stage changes.

Recent increases in tritium concentrations were observed close to the 200E Area in wells 6-32-43 and 6-33-42 (located in Figure 3.10). These

two wells, which were drilled in 1977, showed decreasing tritium concentrations during the time the PUREX Plant was shut down, and then increasing concentrations in 1985 as a result of increased liquid waste disposal in early 1984 (Figure 3.16). These increased concentrations indicated the presence of a second, smaller area of tritium concentrations that were above 200,000 pCi/L in the region near the PUREX Plant (south-east corner of the 200E Area) (Figure 3.12).

Another major tritium plume, in the southern portion of the 200W Area, emanated from the REDOX Plant, which processed fuel from 1951 until 1967. This plume was less widespread and had higher concentrations than the first plume produced by the PUREX Plant. The lower hydraulic conductivity of the geologic media resulted in slower ground-water flow rates near the 200W Area.

Figure 3.12 shows 1986 tritium concentrations that were above 5000 pCi/L in the northern region of the 200W Area, in the region east of the 200E Area (near B Pond), and between Gable Butte and Gable Mountain. These plumes are the result of past Hanford operations. The waste disposal practices that created these plumes were not identified.

A comparison of the average tritium concentrations in each well for 1986 (Figure 3.12) showed one plume near REDOX at levels above the DCG (2,000,000 pCi/L). Several locations showed tritium concentrations above the DWS (20,000 pCi/L). These locations included 1) isolated portions of the 100B, 100F, 100K and 100N Areas, 2) the 200W Area, and 3) the large plume located between the 200E Area and the Columbia River.

During 1986, samples from ten wells were analyzed for gross alpha activity in the area of the highest tritium concentrations to the south of and along the Columbia River and just south of the midpoint between the 200W and 200E

The per capita dose was calculated to be 0.004 mrem (0.00004 mSv).

RADIOLOGICAL IMPACT FROM PUREX PLANT OPERATIONS

The PUREX Plant restarted operations in November 1983 and continued operations through September 1986. In addition to the dose contributions identified earlier from PUREX Plant operations, other minor dose contributions of interest are discussed here. The greatest percentage of airborne emission from the PUREX Plant in 1986 was 500,000 Ci of ^{85}Kr (see Table G.1, Appendix G). Krypton-85 is an inert gas and is not retained in environmental media or the human body. The dose from inhaling ^{85}Kr is small compared with doses from other radionuclides. Even though the curie quantity of this radionuclide was large, it was a minor contributor to the radiation dose. The average concentration of ^{85}Kr measured in 1986 at the perimeter monitoring stations was 100 pCi/m^3 , which was calculated to produce a potential effective dose of 0.002 mrem to an individual who was at that location 100% of the time.

In 1986, there was also 0.003 Ci of $^{239,240}\text{Pu}$ in airborne emissions from the PUREX Plant (see Table G.1, Appendix G), compared to 0.01 Ci in 1985. Plutonium-239,240 was also a minor contributor to the dose from 1986 Hanford operations, with a maximum potential effective dose of 0.002 mrem (0.00002 mSv).

RADIOLOGICAL IMPACT ON DRINKING WATER FROM WELLS

During 1986, ground water was used as the source of drinking water for the 400 Area (FFTF), the Yakima Barricade Guardhouse, and the Hanford Patrol Training Academy. Samples were collected from these systems throughout the year in accordance with applicable drinking water regulations. With the exception of tritium concentrations measured in the drinking water at the FFTF, 1986 results were similar to those observed during previous years. Tritium concentrations in the drinking water at the FFTF decreased from an average of 22,000 pCi/L in 1985 to 8,500 pCi/L in 1986 as a result of drilling a new, deeper well for the drinking water source.

The effective dose to a worker at FFTF consuming 250 L of such water during 1986 was estimated to be 0.13 mrem or 3% of the Washington State Drinking Water Standard of 4 mrem/yr. Radionuclide concentrations observed during 1986 were well below applicable drinking water limits in all cases. The monitoring results, non-radiological as well as radiological, from the Hanford Sanitary Water Quality Surveillance Program are discussed in more detail and reported annually by HEHF (Somers 1987).

REFERENCE 3

Investigation of Ground-Water-Seepage from the Hanford
Shoreline of the Columbia River, PNL-5289, November 1984

6060 9129 16
943218 0909

Investigation of Ground- Water Seepage from the Hanford Shoreline of the Columbia River

W. D. McCormack
J. M. V. Carlile

November 1984

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute



PNL-5289

17

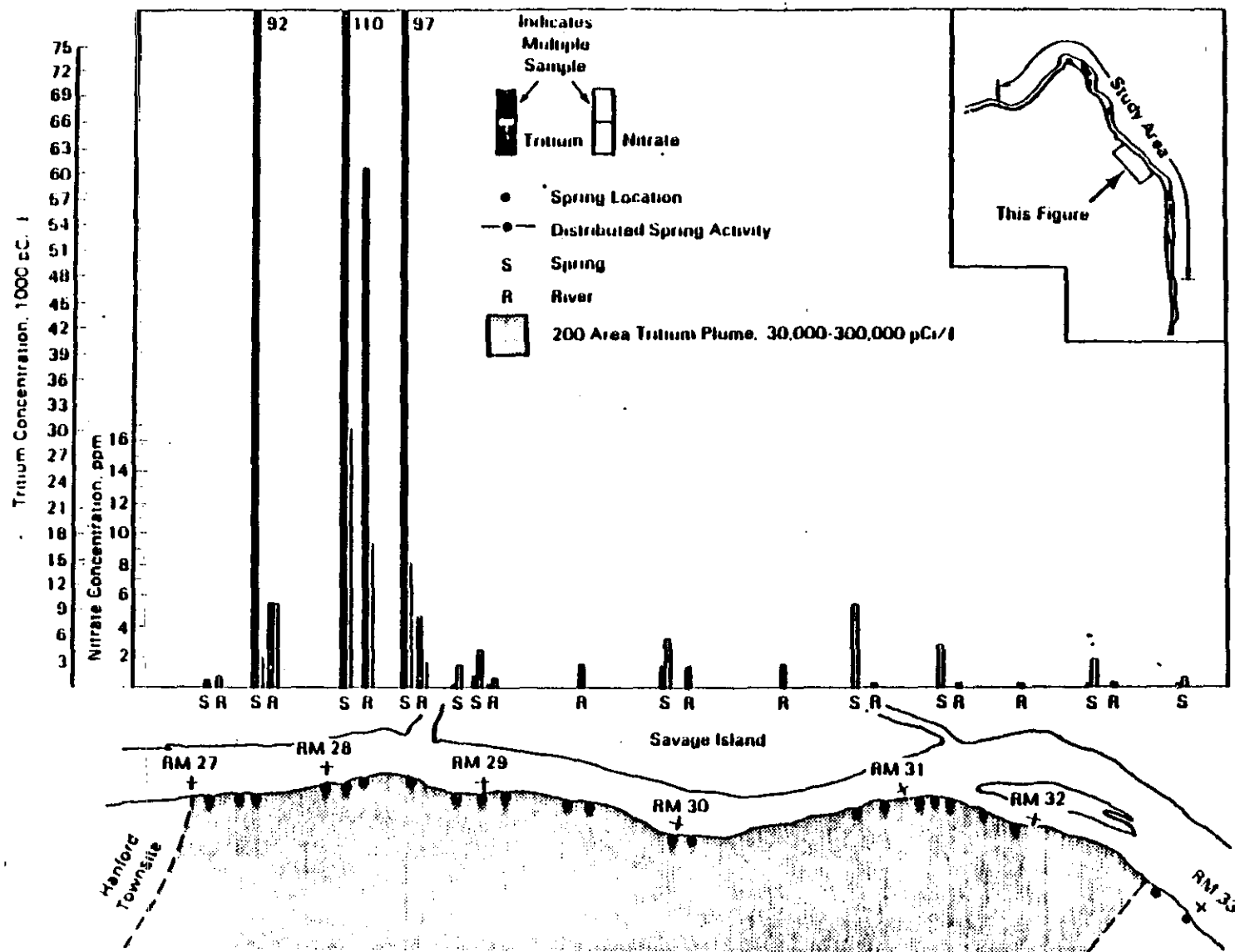


FIGURE 5. Locations and Analytical Results for Spring and River Samples - River Mile 27 through River Mile 33

TABLE A.1. Shoreline Inspection Record (Cont'd.)

River mile location	Starting Destination	Inspection Date/Time	Description
25.75	25-4	11:47	11.3°C, heavy flow, just DS (b) boat ramp (ferry landing), sand cave in bank, entire cave spring activity, 11.3°C
	25-5	12:00	11.8°C, heavy flow, 50 y DS ferry landing
25.8	25-6	12:05	10.6°C, heavy flow, 6 ft wide stream, 150 y DS ferry landing
26.2	26-1	11:20	10.9°C, heavy flow, springs across inlet at TLJ location, 10 ft from river's edge, small cobbles with mud and silt
26.25	26-2	11:40	heavy overall flow/moderate individually, 200 ft wide indentation in bank, flat mud and sand beach topped by boulders, 200 ft DS 26-1
26.6	26-3	12:20	moderate flow, streams trickling down from area of patches located up the bank, pool 20 ft from river's edge, at foot of trail US (a) from well 48-7
26.8	26-4	12:30	heavy flow, stony beach with cobble lenses, inside wide bay in bank below bluff, emanating from middle cobble lens, 20 ft from river's edge, rivulets extend 20 ft into river
27.0	27-1	11-6-82/8:30 a.m.	12.6°C, heavy flow, broad depressed area forming indentation in bank, flow from 100 y wide area, 100 y DS 26-4 27
27.25	27-2	9:04	12.7°C, heavy flow, broad ditched area, surrounded by numerous patches, cobble with mud in depressions
27.5	27-3	9:15	12.5°C, heavy flow, broad 100 y wide ditched area, broad cobble scattering, fine silt in areas of springs - 50 y DS 27-1, ditched area - 100 DS 27-3 broad shallow depression 100 y US 26-2, several flowing patches
28	28-1	9:10	12.5°C, moderate flow, continuous 200 y DS
	28-2	9:30	12.3°C, heavy flow, bluff recedes, rocky point in river, DS side of point major flow
28.25	28-3	9:40	12.2°C, large pool 50 ft diameter
28.5	28-4	10:00	12.1°C, large pool DS from point and bend in river, US from narrow beach and bluffs to 26-23 - saturated sand area US from 26-23
29.25	29-1	10:00	13°C, moderate flow, small depressed area and patches, 150 y wide
29.5	29-2		12.8°C, saturated mud and silt, signs of recent surface flow, buried pipe and timber across hole in bank.
29.75	29-3		12.3°C, saturated mud and silt, no flow on surface
30.0	30-0	10:30	11.7°C, intermittent saturated areas 100 y DS 26 30
	30-1		12.9°C, low flow, narrow shore, 250 y DS 26 30
30.9	30-2		12.0°C, very low flow, 100 y US 26 31, numerous patches extensive fine mud and silt, signs of recent runoff
31.0	31-1		saturated area, located behind point in back eddy, no obvious sign
31.3	31-2		12.8°C, more sand present, moderate flow
31.5	31-3		12.8°C, low flow, saturated area, in back eddy
31.6	31-4		13.4°C, heavy flow, cobble area separating narrow sandy beaches, opposite US end of Kingsid is. and numerous sandy beaches 250 y US and 1 mile DS, saturated and oozing water, rivulets flowing, 1st layer of silt, 2nd layer coarse sand, 3rd layer silt, hole in sand 13:1, fills rapidly
31.6	31-5		11.7°C, low flow, dry rivulets and saturated beaches, dryer for rest of 26 31, sand more compact
33.0	33-1	12:30	

(a) US - upstream
(b) DS - downstream
(c) 26 - Silver Mile

TABLE B.1. Strontium-90 Analyses from Columbia River Samples

River Mile Location	Sample ID	Date Collected	Concentration, $pCi/l \pm 2\sigma$
3.0-5.0	B Comp RW ^(a)	01/22/83	0.55 ± 0.23
5.5-7.5	K Comp RW	12/18/82	0.18 ± 0.02
8.0-9.5	N Comp RW	12/18/82	28 ± 0.47
10.0-12.0	D Comp RW	12/18/82	1.1 ± 0.05
14.0-17.5	H Comp RW	01/22/83	0.50 ± 0.14
18.0-22.0	F Comp RW	01/22/83	0.93 ± 0.15
Upstream Columbia River Concentration (Average 1983)			0.18 ± 0.22
DOE Concentration Guide (USDOE 1981)			300

(a) Comp-RW denotes composite river water sample comprised of aliquots from immediately preceding river sample locations.

TABLE B.2. Iodine-129 Analyses from Spring and Columbia River Samples

River Mile Location	Sample ID	Date Collected	Concentration, $pCi/l \pm 2\sigma$
27.0	27.0 RW ^(a)	01/22/83	$3.3 \times 10^{-6} \pm 1.4 \times 10^{-6}$ BKG
27.0	27-1 Sp ^(b)	09/11/83	$1.6 \times 10^{-4} \pm 2.1 \times 10^{-5}$ DG
28.0	28-2 Sp	09/11/83	$6.2 \times 10^{-2} \pm 6.8 \times 10^{-3}$
29.0	29.0 RW	01/22/83	$6.3 \times 10^{-5} \pm 5.0 \times 10^{-6}$
31.75	31-5 Sp	09/11/83	$3.0 \times 10^{-5} \pm 4.0 \times 10^{-6}$
32.5	32-0 Sp	09/11/83	$4.4 \times 10^{-5} \pm 2.7 \times 10^{-5}$
Upstream Columbia River Concentration (1983 Average)			$2.4 \times 10^{-5} \pm 2.6 \times 10^{-5}$
DOE Concentration Guide (USDOE 1981)			60

(a) RW denotes composite river water sample.
(b) Sp denotes river bank spring sample.

TABLE C.1. (contd)

Sample Collection				Analyses			
River Mile Location (a)	Sample ID	Sample Size	Date/Time Collected	$^3\text{H}_2$ pCi/l $\pm 2\sigma$	NO_3^- ppm	U_6 pCi/l $\pm 2\sigma$	Comments
25.3	25-1 Sp (d)	1L	01-22-83/1550	$3.80 \times 10^2 \pm 2.06 \times 10^2$	0.22		7.0°C
25.5	25-3 Sp	1L	01-22-83/0945	$3.10 \times 10^2 \pm 2.06 \times 10^2$	0.66		4.9°C
		1L	09-11-83/1300	$5.34 \times 10^2 \pm 2.10 \times 10^2$	0.47		17.7°C
25.8	25-4 Sp	1L	01-22-83/1710	$(1.36 \times 10^2 \pm 2.11 \times 10^2) (f)$	1.11		7.1°C
26.2	26-1 Sp	1L	01-22-83/1015	$3.21 \times 10^2 \pm 2.06 \times 10^2$	1.33		4.9°C
		1L	09-11-83/1245	$(8.15 \times 10^1 \pm 2.08 \times 10^2)$	0.55		21.4°C
27.0	27.0 BKG (b)	1L	09-11-83/1225	$(1.07 \times 10^2 \pm 2.01 \times 10^2)$	0.09		17.4°C mid river BKG
	27.0 RM (c)	1L	01-22-83/1127	$(-4 \times 10^0 \pm 2.10 \times 10^2)$	0.75		2 L for 27/29 comp.
		1L	09-11-83/1221	$(1.55 \times 10^2 \pm 2.02 \times 10^2)$	0.21		2 L for 27/29 comp.
	27-1 Sp	1L	01-22-83/1125	$2.92 \times 10^2 \pm 2.05 \times 10^2$	0.58		4.5°C
		1L	09-11-83/1215	$3.69 \times 10^2 \pm 2.06 \times 10^2$	0.73		15.1°C
27.5	27.5 RM	1L	01-22-83/1338	$1.05 \times 10^4 \pm 3.42 \times 10^2$	5.53		2 L for 27/29 comp. DG
		1L	09-11-83/1200	$2.76 \times 10^4 \pm 2.54 \times 10^4$	0.05		2 L for 27/29 comp.
	27-3 Sp	1L	01-22-83/1336	$8.03 \times 10^2 \pm 3.16 \times 10^2$	1.99		8.2°C
		1L	09-11-83/1206	$9.17 \times 10^4 \pm 9.18 \times 10^2$	3.05		16.7°C
28.0	28.0 RM	1L	01-22-83/1400	$4.88 \times 10^4 \pm 6.10 \times 10^2$	9.52		2 L for 27/28 comp.
		1L	09-11-83/1157	$6.06 \times 10^4 \pm 7.61 \times 10^2$	1.18		2 L for 27/29 comp.
	28-2 Sp	1L	01-22-83/1400	$7.98 \times 10^4 \pm 7.79 \times 10^2$	16.6		11.1°C
		1L	09-11-83/1150	$1.10 \times 10^5 \pm 9.95 \times 10^2$	4.65		17.4°C
28.5	28.5 RM	1L	01-22-83/1225	$1.11 \times 10^3 \pm 2.22 \times 10^2$			2 L for 27/29 comp.
		1L	09-11-83/1140	$7.92 \times 10^3 \pm 3.28 \times 10^2$	2.35		2 L for 27/29 comp.
	28-4 Sp	1L	01-22-83/1425	$2.32 \times 10^4 \pm 4.54 \times 10^2$	7.52		5.9°C
		1L	09-11-83/1136	$9.69 \times 10^4 \pm 9.40 \times 10^2$	8.2		19.8°C
28.8	28-5 Sp	1L	01-22-83/1517	$4.31 \times 10^2 \pm 2.15 \times 10^2$	1.55		new location-middle of beach between Sp 28-4 and RM 29

(a-f) Key found at end of table.

TABLE C.1. (contd)

Sample Collection				Analysis			
River Mile Location ^(a)	Sample ID	Sample Size	Date/Time Collected	$^3\text{H}_2$ pCi/l $\pm 2\sigma$	NO_3^- ppm	U_6 pCi/l $\pm 2\sigma$	Comments
29.0	29.0 RW ^(c)	1L	01-22-83/1240	$(1.01 \times 10^2 \pm 2.11 \times 10^2)^{(f)}$	0.71		
		1L	09-11-83/1119	$4.11 \times 10^3 \pm 2.75 \times 10^2$	0.24		2 L for 27/29 comp.
	29-0 Sp ^(d)	1L	01-22-83/1255	$1.63 \times 10^3 \pm 2.34 \times 10^2$	2.65		new location-beach below RM 29
	27/29 comp. RW ^(e)	10L	01-22-83/1430	$(1.23 \times 10^4 \pm 3.60 \times 10^4)$	2.65		2 L for 27/29 comp.
		10L	09-11-83/1221	$1.17 \times 10^4 \pm 3.74 \times 10^2$	0.35		
29.5	29.5 RW	1L	09-11-83/1100	$2.56 \times 10^3 \pm 2.48 \times 10^2$	<0.02		2.5 L for 29/31 comp.
30.0	30.0 RW	1L	09-11-83/1033	$2.32 \times 10^3 \pm 2.44 \times 10^2$	0.15		2.5 L for 29/31 comp.
	30-1 Sp	1L	09-11-83/1025	$2.73 \times 10^3 \pm 2.52 \times 10^2$	3.14		20.4°C
30.5	30.5 RW	1L	09-11-83/1012	$2.73 \times 10^3 \pm 2.51 \times 10^2$	0.05		2.5 L for 29/31 comp.
31.0	31.0 RW	1L	09-11-83/1009	$9.38 \times 10^2 \pm 2.20 \times 10^2$	0.05		2.5 L for 29/31 comp.
	31-1 Sp	1L	09-11-83/1005	$(1.57 \times 10^2 \pm 2.02 \times 10^2)$	3.25		15.8°C
	29/31 comp. RW	10L	09-11-83/1100	$2.07 \times 10^3 \pm 2.39 \times 10^2$	0.26		
31.5	31.5 RW	1L	09-11-83/0946	$6.86 \times 10^2 \pm 2.13 \times 10^2$	0.15		2.5 L for 31/33 comp.
31.75	31-5 Sp	1L	09-11-83/0950	$(1.90 \times 10^2 \pm 2.02 \times 10^2)$	2.64		17.4°C
32.0	32.0 RW	1L	09-11-83/0923	$4.69 \times 10^2 \pm 2.09 \times 10^2$	0.09		2.5 L for 31/33 comp.
32.5	32.5 RW	1L	09-11-83/0912	$8.06 \times 10^2 \pm 2.16 \times 10^2$	0.11		2.5 L for 31/33 comp.
	32-0 Sp	1L	09-11-83/0927	$3.17 \times 10^2 \pm 2.06 \times 10^2$	1.78		17.8°C
33.0	33.0 RW	1L	09-11-83/0900	$(1.30 \times 10^2 \pm 2.04 \times 10^2)$	0.05		2.5 L for 31/33 comp.
	33-1 Sp	1L	09-11-83/0900	$5.73 \times 10^2 \pm 2.11 \times 10^2$	0.75		17.9°C
	31/33 comp. RW	10L	09-11-83/0950	$4.31 \times 10^2 \pm 2.08 \times 10^2$	0.15		
37.2	37-1 Sp	1L	12-20-82/1047	$1.19 \times 10^3 \pm 2.30 \times 10^2$	5.31		6.7°C
38.25	38-1 Sp	1L	12-20-82/1120	$4.72 \times 10^2 \pm 2.50 \times 10^2$	4.65		6.4°C
41.5	41.5 RW	1L	12-20-82/1235		0.62	0.408 \pm 0.143	2 L for 41.5/44 comp.; 6.2°C
41.8	41-1 Sp	1L	12-20-82/1235		3.98	9.03 \pm 3.16	11.1°C

(a-f) Key found at end of table.

REFERENCE 4

Uncontrolled Hazardous Waste Site Ranking System;

A Users Manual, 40 CFR 300, Appendix A

Part 300, App. A

Physical state refers to the state of the hazardous substances at the time of disposal, except that gases generated by the hazardous substances in a disposal area should be considered in setting this factor. Each of the hazardous substances being evaluated is assigned a value as follows:

Physical state	Assigned value
Gas, completely or substantially	3
Liquid, completely or substantially	2
Solid, completely or substantially	1
Other	0

3.2 Containment

Containment is a measure of the natural or artificial means that have been used to maintain or prevent a contaminant from entering ground water. Examples include liners, leachate collection systems, and sealed containers. In assigning a value to this rating factor (Table 3), consider all ways in which hazardous substances are stored or disposed at the facility. If the facility involves more than one method of storage or disposal, assign the highest from among all applicable values (i.e., if a landfill has a containment value of 1, and at the same location a surface impoundment has a value of 2, assign containment a value of 2).

TABLE 3—CONTAINMENT VALUE FOR GROUND WATER RISK

Assign containment a value of 0, 1, 2, or 3, as the hazardous substances are stored or disposed at the facility. For example, if a facility uses a landfill, assign a value of 1. If the facility uses a surface impoundment, assign a value of 2. If the facility uses a combination of methods, assign the highest value.

Containment	Assigned value
Landfill	1
Surface impoundment	2
Other	0

40 CFR Ch. I (7-1-06 Edition)

TABLE 3—CONTAINMENT VALUE FOR GROUND WATER RISK—Continued

Assign containment a value of 0, 1, 2, or 3, as the hazardous substances are stored or disposed at the facility. For example, if a facility uses a landfill, assign a value of 1. If the facility uses a surface impoundment, assign a value of 2. If the facility uses a combination of methods, assign the highest value.

Containment	Assigned value
Landfill	1
Surface impoundment	2
Other	0

C. Phase

Phase measures and waste contained in gas, liquid, or solid form. Assign a value of 0, 1, 2, or 3, as the hazardous substances are stored or disposed at the facility. For example, if a facility uses a landfill, assign a value of 1. If the facility uses a surface impoundment, assign a value of 2. If the facility uses a combination of methods, assign the highest value.

D. Leachate

Leachate measures and waste contained in gas, liquid, or solid form. Assign a value of 0, 1, 2, or 3, as the hazardous substances are stored or disposed at the facility. For example, if a facility uses a landfill, assign a value of 1. If the facility uses a surface impoundment, assign a value of 2. If the facility uses a combination of methods, assign the highest value.

Assign leachate a value of 0, 1, 2, or 3, as the hazardous substances are stored or disposed at the facility. For example, if a facility uses a landfill, assign a value of 1. If the facility uses a surface impoundment, assign a value of 2. If the facility uses a combination of methods, assign the highest value.

3.4 Waste Characteristics

Waste characteristics measure the hazardousness of the waste. Assign a value of 0, 1, 2, or 3, as the hazardous substances are stored or disposed at the facility. For example, if a facility uses a landfill, assign a value of 1. If the facility uses a surface impoundment, assign a value of 2. If the facility uses a combination of methods, assign the highest value.

Assign waste characteristics a value of 0, 1, 2, or 3, as the hazardous substances are stored or disposed at the facility. For example, if a facility uses a landfill, assign a value of 1. If the facility uses a surface impoundment, assign a value of 2. If the facility uses a combination of methods, assign the highest value.

Environmental Protection Agency

of the most hazardous substances at the facility independently and enter only the highest score in the matrix on the work sheet.

Value for persistence	Value for toxicity	Value for mobility	Value for reactivity
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3

Persistence of each hazardous substance is evaluated on the biodegradability as follows:

Biodegradability	Assigned value
Highly biodegradable	1
Biodegradable	2
Not biodegradable	3

More specific information is given in Tables 4 and 5.

TABLE 4—WASTE CHARACTERISTICS VALUES FOR SOME COMMON CHEMICALS

Chemical/Compound	Toxicity	Persistence	Reactivity	Biodegradability
Acetylene	1	1	1	1
Acetic Acid	1	1	1	1
Acetone	1	1	1	1
Aluminum Hydroxide	1	1	1	1
Ammonia	1	1	1	1
Carbon Dioxide	1	1	1	1
Chlorine	2	2	2	2
Chloroform	2	2	2	2
Cyanide	2	2	2	2
Dioxin	3	3	3	3
Fluorine	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2
Hydrogen Peroxide	1	1	1	1
Hydrochloric Acid	1	1	1	1
Hydrofluoric Acid	2	2	2	2
Hydrogen Sulfide	1	1	1	1
Hydroxide	1	1	1	1
Hydrogen Cyanide	2	2	2	2

REFERENCE 5

Handbook of 200 Area Waste Sites, Volume I
1979 Rockwell Hanford Operations, RHO-CD-673

INDEX - VOLUME I 200 EAST AREA

Southeast Quadrant

216-A-2 Crib	I. SE	216-A-33 French Drain	I. SE
216-A-3 Crib	I. SE	216-A-35 French Drain	I. SE
216-A-4 Crib	I. SE	216-A-36A Crib	I. SE
216-A-5 Crib	I. SE	216-A-36B Crib	I. SE
216-A-9 Crib	I. SE	216-A-38 Crib	I. SE
216-A-10 Crib	I. SE	216-A-39 Crib	I. SE
216-A-11 Crib	I. SE	216-A-40 Trench	I. SE
216-A-12 French Drain	I. SE	216-A-41 Crib	I. SE
216-A-13 French Drain	I. SE	216-C-1 Crib	I. SE
216-A-14 French Drain	I. SE	216-C-2 Crib	I. SE
216-A-15 French Drain	I. SE	216-C-3 Crib	I. SE
216-A-16 French Drain	I. SE	216-C-4 Crib	I. SE
216-A-17 French Drain	I. SE	216-C-5 Crib	I. SE
216-A-21 French Drain	I. SE	216-C-6 Crib	I. SE
216-A-22 Crib (Fr. Drain)	I. SE	216-C-7 Crib	I. SE
216-A-23A French Drain	I. SE	216-C-10 Crib	I. SE
216-A-23B French Drain	I. SE	218-E-1 Burial Ground	I. SE
216-A-26A French Drain	I. SE	218-E-13 Burial Ground	I. SE
216-A-26B French Drain	I. SE	218-E-14 Purex Tun. Stor.	I. SE
216-A-27 Crib	I. SE	218-E-15 Purex Tun. Stor.	I. SE
216-A-28 Crib	I. SE		
216-A-31 Crib	I. SE		
216-A-32 Crib	I. SE		

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-A-2 Cavern	216-A-2
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, SE Quadrant 200 East Area, 260 ft south of 202A Bldg. 900 ft west of Canton Avenue S.W. of the 291-A-1 stack.	1/56-1/63	Inactive
<u>Site Coordinates</u> (Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>
N-39515, W-48278	H-2-56049 H-2-56050	Ground 712 ft Water Table 403 ft (1973) Site Depth 28 ft

Source and Description of Waste

2.3 x 10⁵ liters. Organic waste from 202A (Purex). Low-salt, neutral-basic.

Description of Facility

Rock structure, 20 ft x 20 ft bottom surface area.

Deactivated, when the specific retention capacity was reached, by removing a section of effluent pipeline.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	130	1.30 x 10 ²
Beta, Ci	590	< 6.49
⁹⁰ Sr, Ci	2	1.24
¹⁰⁶ Ru, Ci	150	3.67 x 10 ⁻⁴
¹³⁷ Cs, Ci	3	1.92
⁶⁰ Co, Ci	1	7.99 x 10 ⁻²
U, kg	78.1	7.91 x 10 ¹

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-A-3 Cavern	216-A-3
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant Directly South of 275-EA Bldg. and ~1200 ft west of Canton Ave.	1/56 to 11/67	Active
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-40530; W-48540	H-2-55900 H-2-56049 H-2-56050	Ground 704 ft Water Table 404 ft Site Depth 16 ft
<u>Source and Description of Waste</u>		
2.8 x 10 ⁶ liters. Silica-Gel regeneration waste from 203-A, the UNH storage pit drainage and the liquid waste from the 203-A Pumphouse.		
<u>Description of Facility</u>		
Rock filled crib. Area 20 ft x 20 ft bottom dimensions.		
<u>Radionuclide Content (calculated from discharge data)</u>		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	0.20	.20
Beta, Ci	882	< 0.263
⁹⁰ Sr, Ci	0.10	5.82 x 10 ⁻²
¹⁰⁶ Ru, Ci	350	7.14 x 10 ⁻⁴
¹³⁷ Cs, Ci	<0.10	< 6.03 x 10 ⁻²
⁶⁰ Co, Ci	<0.10	< 5.50 x 10 ⁻³
U, kg	1.7 x 10 ³	1.68 x 10 ³
<u>History:</u>		
Receives UNH storage pit drainage, the liquid waste from the 203-A Pumphouse and 203-A Bldg enclosure sumps, and the heating coil condensate from the P-1 through P-4 UNH tanks. The discharge of silica gel to this crib was discontinued sometime between 1967 and 1970.		

9413218-1322

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-A-4 Cavern	216-A-4
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant 260 ft south of 202-A Bldg. 760 ft west of Canton Ave. 150 ft east of 216-A-2.	12/55-12/58	Inactive
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-39515, W-48158	H-2-56049 H-2-56050	Ground 710 ft Water Table 403 ft(1973) Site Depth 25 ft

Source and Description of Waste

6.21 x 10⁶ liters. Laboratory cell drainage from the Purex Plant and 291-A-1 stack drainage. Low-salt, neutral-basic.

Description of Facility

Rock structure 20 ft x 20 ft bottom surface area.
Deactivated when the specific retention capacity was reached by blanking the pipeline inlet to the crib.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	140	1.40 x 10 ²
Beta, Ci	864	2.96 x 10 ¹
⁹⁰ Sr, Ci	10	5.93
¹⁰⁶ Ru, Ci	400	2.05 x 10 ⁻⁴
¹³⁷ Cs, Ci	15	9.19
⁶⁰ Co, Ci	1	6.07 x 10 ⁻²
U, kg	399	3.99 x 10 ²

913218-0323

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-A-5 Cavern	216-A-5
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant 450 ft south of 202-A Bldg. 1400 ft west of Canton Ave.	12/55-11/61	Inactive
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-39510, W-48750	H-2-55900 H-2-56049 H-2-56050	Ground 710 ft Water Table 404 ft (1973) Site Depth 32 ft

Source and Description of Waste

1.63 x 10⁹ liters. Process condensate from 202-A. Acidic.

Description of Facility

One crib, rock structure, 35 ft x 35 ft bottom surface.
Deactivation: Effluent pipeline to crib was blanked out.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	65	6.50 x 10 ¹
Beta, Ci	3400	< 1.54 x 10 ²
⁹⁰ Sr, Ci	90	5.62 x 10 ¹
¹⁰⁶ Ru, Ci	150	5.05 x 10 ⁻⁴
¹³⁷ Cs, Ci	25	1.61 x 10 ¹
⁶⁰ Co, Ci	110	8.94
U, kg	263	2.63 x 10 ²
²³³ U, g	none	

Site Characterization Status

Well No E24-1A was drilled to a depth of 320 ft at the south edge of the 216-A-5 crib in 1966 to determine locations and concentrations of subsurface contamination. Analytical data on core samples from this well show rapidly decreasing ¹³⁷Cs concentrations from a moderate level of 4.4 x 10⁻³ µCi/g at about 35 ft to a low level of 10⁻⁵ µCi/g at about 65 ft. The ¹³⁷Cs values were at or below the detection limit of 10⁻⁵ µCi/g throughout most of the soil column. The ⁹⁰Sr concentrations were below the detection limit (3.2 x 10⁻⁵ µCi/g).

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	--	216-A-9
<u>Location</u> 200 East, S.E. Quadrant 500 ft west of 241-A Tank Farm 900 ft north of 275-EA Bldg.	<u>Service Dates</u> 3/56-2/58 4/66-10/66 8/69-8/69	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-41000, W-48355 to N-41297, W-48652	<u>Reference Drawings</u> H-2-55577 H-2-55578 H-2-55579	<u>Elevations</u> Ground 694 ft Water Table 404 ft(1973) <u>Site Depth</u> 12 ft
<u>Source and Description of Waste</u> 9.81 x 10 ⁶ liters. <u>Acid fractionator condensate</u> and condenser cooling water from 202-A (3/56-2/58); N Reactor decontamination waste (1966); acid fractionator condensate (1969). <u>Acidic.</u>		
<u>Description of Facility</u> One crib, rock structure, 420 ft x 20 ft bottom area. Deactivation: Effluent pipeline was blanked north of 202-A-3 Bldg. after replacing 100 ft of effluent pipeline which failed.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	0.5	.50
Beta, Ci	190	<41.8
⁹⁰ Sr, Ci	25	14.9
¹⁰⁶ Ru, Ci	50	1.70 x 10 ⁻⁴
¹³⁷ Cs, Ci	10	6.17
⁶⁰ Co, Ci	0.14	1.57 x 10 ⁻²
U, kg	0.23	0.227
<u>Site Characterization Status</u> Well E24-3 monitors the southeast end of the 216-A-9 Crib. Waste disposed at this site contained only an estimated 54 Ci of radioactivity. No ground contamination was noted on the 1959 scintillation well log. A small amount of contamination from 30 ft to 100 ft below ground surface is indicated on the 1963 log.		

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	--	216-A-10
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant Approximately 270 ft south of the southwest corner of 202-A.	11/61-	Active
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-39090, W-48952 to N-39370, W-48952	H-2-55576 H-2-55578 H-2-58131	Ground 714 ft Water Table 404 ft(1973) Site Depth 45 ft <i>1 doubt this is a</i>

Source and Description of Waste

2.9 x 10⁹ liters. Process condensate from 202-A. Acidic.

Description of Facility

Crib, rock-filled. 275 ft x 45 ft bottom dimensions.

Radionuclide Content (calculated from discharge data)

<u>Radionuclides</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	3.4 x 10 ²	343.0
Beta, Ci	8.1 x 10 ⁵	< 720.0
⁹⁰ Sr, Ci	1.5 x 10 ²	111.0
¹⁰⁶ Ru, Ci	7.3 x 10 ³	5.49
¹³⁷ Cs, Ci	1.3 x 10 ²	106.0
⁶⁰ Co, Ci	1.8 x 10 ²	26.7
U, kg	2.0 x 10 ²	204.0
²³³ U, g	2.8 x 10 ²	277.0

Site Characterization Status

Ground water samples taken from monitoring wells near the 216-A-10 crib prior to 1967 show ⁹⁰Sr concentrations slightly above detection limit (1 x 10⁻³ Ci/cc). However, only small quantities of ⁹⁰Sr (57 curies) had been disposed to this site. The acidic nature of this waste increases the mobility of ⁹⁰Sr through the soil column.

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u> French Drain	<u>Past Designation</u> --	<u>Number</u> 216-A-11
<u>Location</u> 200 East, S.E. Quadrant Southeast corner of 202-A	<u>Service Dates</u> 1/56-	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-39780, W-48050	<u>Reference Drawings</u> H-2-55090 H-2-55091 H-2-55095	<u>Elevations</u> Ground 708 ft Water Table 404 ft(1973) Site Depth 30 ft
<u>Source and Description of Waste</u> Volume unknown, steam trap Pit No. 1 drainage from 202-A. Low-salt, neutral/basic.		
<u>Description of Facility</u> French drain, 30 in. diameter		
<u>Radionuclide Content</u> (calculated from discharge data) <50 Ci Beta		

Ref. 5.8

943210-030

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u> French Drain	<u>Past Designation</u> --	<u>Number</u> 216-A-12
<u>Location</u> 200 East, SE Quadrant Center of South side of 202-A, approximately 75 ft from the building.	<u>Service Dates</u> 11/55-	<u>Status</u> Inactive
<u>Site Coordinates (Approximate)</u> N-39780, W-48503	<u>Reference Drawings</u> H-2-53014 H-2-55090 H-2-55092	<u>Elevations</u> Ground 708 ft Water Table 404 ft(1973) Site Depth 33 ft
<u>Source and Description of Waste</u> Volume unknown, steam trap Pit No. 3 drainage from 202-A. Low-salt, neutral/basic.		
<u>Description of Facility</u> French drain, 30 in. diameter.		
<u>Radionuclide Content (calculated from discharge data)</u> <50 Ci total Beta		

Ref. 5.9

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>		<u>Past Designation</u>	<u>Number</u>
French Drain		--	216-A-13
<u>Location</u> 200 East, S.E. Quadrant West end of 202-A Bldg.		<u>Service Dates</u> 1/56-12/62	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>	
N-39814, W-49010	SK-22568 H-2-55076	Ground 708 ft Water Table 403 ft Site Depth 18 ft	
<u>Source and Description of Waste</u>			
Volume unknown, Seal water from the air sampler vacuum pumps in the 202-A Bldg. Low-salt, neutral/basic.			
<u>Description of Facility</u>			
French Drain, 2 ft diameter.			
<u>Radionuclide Content</u> (calculated from discharge data)			
Total Beta: <1 Ci			

Ref. 5.10

947320.0329

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>		<u>Past Designation</u>	<u>Number</u>
French Drain		--	216-A-14
<u>Location</u> 200 East, S.E. Quadrant		<u>Service Dates</u>	<u>Status</u>
South side of the center of the 202-A Bldg. approximately 75 ft, and 75 ft west of 216-A-12.		1/87 to present 1.5-	Inactive
<u>Site Coordinates</u> (Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>	
N-39742, W-48551	H-2-53465 H-2-55090	Ground 708 ft Water Table 403 ft Site Depth 29 ft	
<u>Source and Description of Waste</u>			
Volume unknown. Vacuum filter and blower pit drainage from the 202-A Bldg. Low-salt, neutral/basic.			
<u>Description of Facility</u>			
French drain, 20 in. diameter.			
<u>Radionuclide Content</u> (calculated from discharge data)			
Total Beta: <1 Ci			

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u> French drain		<u>Past Designation</u> --	<u>Number</u> 216-A-15
<u>Location</u> 200 East, S.E. Quadrant Approximately 325 ft South of the center of 202-A		<u>Service Dates</u> 12/55-	<u>Status</u> Inactive
<u>Site Coordinates (Approximate)</u> N-39516, W-48656	<u>Reference Drawings</u> H-2-56045-2	<u>Elevations</u> Ground 712 ft Water Table 404 ft(1973) <u>Site Depth</u> 44 ft	
<u>Source and Description of Waste</u> Volume unknown. - Drainage from 216-A-10 process condensate sample pit. <u>Acidic.</u>			
<u>Description of Facility</u> French drain, 2 ft diameter.			
<u>Radionuclide Content (calculated from discharge data)</u> <50 Ci total Beta			

Ref. 5.12

913216.035

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u> French Drain		<u>Past Designation</u> 216-A-16 Dry Well	<u>Number</u> 216-A-16
<u>Location</u> 200 East, within the confines of the 241-A Tank Farm		<u>Service Dates</u> 1/56-3/69	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-41191, W-47453	<u>Reference Drawings</u> H-2-55943 H-2-56521	<u>Elevations</u> Ground 586 ft Water Table 404 ft(1973) <u>Site Depth</u> 17 ft	
<u>Source and Description of Waste</u> Volume unknown. Floor drainage and 296-A-11 stack drainage from the 241-A-431 Bldg. Low-salt, neutral/basic.			
<u>Description of Facility</u> French drain, 4 ft diameter.			
<u>Radionuclide Content</u> (calculated from discharge data) Total Beta: <10 Ci			

Ref. 5.13

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u> French Drain		<u>Past Designation</u> 216-A-17 Dry Well	<u>Number</u> 216-A-17
<u>Location</u> 200 East, within the confines of the 241-A Tank Farm.		<u>Service Dates</u> 1/56-3/69	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-41181, W-47453	<u>Reference Drawings</u> H-2-55943 H-2-56521 H-2-56900	<u>Elevations</u> Ground 686 ft Water Table 404 ft(1973) <u>Site Depth</u> 17 ft	
<u>Source and Description of Waste</u> Volume unknown. Floor drainage and 296-A-11 stack drainage from the 241-A-431 Bldg. (overflow). Low-salt, neutral/basic.			
<u>Description of Facility</u> French drain, 4 ft diameter.			
<u>Radionuclide Content</u> (calculated from discharge data) Total Beta: <1 Ci			

Ref. 5.14

9413218.033

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-A-21 Crib	216-A-21
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant 200 East Area, 600 ft south of 202-A Bldg. 750 ft west of Canton Ave.	10/57-6/65	Inactive
<u>Site Coordinates</u> (Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>
N-39300, W-48160	H-2-57042 H-2-57032 H-2-57033	Ground 711 ft Water Table 403 ft (1973) Site Depth 19 ft

Source and Description of Waste

7.78 x 10⁷ liters. From 10/57 to 6/58, received sump waste from 293-A Bldg. From 12/58 to 6/65, received 293-A sump waste, Purex Laboratory cell drainage and 291-A-1 stack drainage. Typically low-salt, neutral-basic; waste could have been acidic at times.

Description of Facility

Gravel structure, 60 ft x 16 ft bottom surface area. Deactivated when the effluent flow rate exceeded the infiltration capacity, by blanking the effluent line to the crib.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	150	150.0
Beta, Ci	2800	225.0
⁹⁰ Sr, Ci	15	10.1
¹⁰⁶ Ru, Ci	200	6.80 x 10 ⁻³
¹³⁷ Cs, Ci	150	104.0
⁶⁰ Co, Ci	10	1.27
U, kg	195	195.0

CONTAMINATED LIQUID DISPOSAL SITES

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib (French Drain)	216-A-22 French Drain	216-A-22
<u>Location</u> 200 East, S.E. Quadrant ~400 ft North of the Center of the 202-A Bldg. Near 216-A-28	<u>Service Dates</u> 3/56-12/58	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-40352, W-48560	<u>Reference Drawings</u> H-2-54812 H-2-54818 H-2-57617 H-2-5517-071	<u>Elevations</u> Ground 708 ft Water Table 404 ft Site Depth 16 ft
<u>Source and Description of Waste</u> Volume unknown. Sump waste from the 203-A Bldg. and heating coil condensate from the P-1 through P-4 UHM tanks. Low-salt, neutral/basic.		
<u>Description of Facility</u> French drain, rock filled, 6-ft. diameter.		
<u>Radionuclide Content</u> (calculated from discharge data) Total Beta: <1 Ci		

Ref. 5.16

947218.036

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>		<u>Past Designation</u>	<u>Number</u>
French Drain		Same	216-A-23A
<u>Location</u>	200 East, S.E. Quadrant-within the confines of the 241-A Tank Farm	<u>Service Dates</u>	<u>Status</u>
		9/57-3/69	Inactive
<u>Site Coordinates</u> (Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>	
N-41171, W-47463	H-2-55943	Ground	686 ft
	H-2-56521	Water Table	404 ft (1973)
	H-2-56999	Site Depth	Not Known
<u>Source and Description of Waste</u>			
Volume unknown. Deentrainer tank condensate and back flush from the 241-A-431 Bldg. Low-salt, neutral/basic.			
<u>Description of Facility</u>			
French drain, 42-in. diameter.			
<u>Radionuclide Content</u> (calculated from discharge data)			
Total Beta: <50 Ci			

Ref. 5.17

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>		<u>Past Designation</u>	<u>Number</u>
French Drain		Same	216-A-238
<u>Location</u> 200 East, S.E. Quadrant-within the confines of the 241-A Tank Farm.		<u>Service Dates</u>	<u>Status</u>
		9/57-3/69	Inactive
<u>Site Coordinates</u> (Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>	
N-41171, W-47473	H-2-55943 H-2-56521 H-2-56999	Ground	686 ft
		Water Table	404 ft (1973)
		<u>Site Depth</u>	NA
<u>Source and Description of Waste</u>			
Volume unknown. Deentrainer tank condensate and the back flush from the 241-A-431 Bldg. (overflow). Low-salt, neutral/basic.			
<u>Description of Facility</u>			
French drain, 42-in. diameter.			
<u>Radionuclide Content</u> (calculated from discharge data)			
Total Beta: <5 Ci			

Ref. 5.18

60-037

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u> French Drain	<u>Past Designation</u> 216-A-25 Crib 216-A-26 French Drain	<u>Number</u> 216-A-26A
<u>Location</u> 200 East, S.E. Quadrant ~100 ft south of the center of the 291-A Bldg.	<u>Service Dates</u> 3/59-7/65	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-39550, W-48208	<u>Reference Drawings</u> H-2-3325 H-2-55036	<u>Elevations</u> Ground 708 ft Water Table 403 ft Site Depth NA
<u>Source and Description of Waste</u> Volume unknown. Floor drainage from the 291-A fan house. Low-salt, neutral/basic.		
<u>Description of Facility</u> French drain, 3-ft. diameter.		
<u>Radionuclide Content</u> (calculated from discharge data) Total Beta: <1 Ci		
<u>History:</u> Removed the 216-A-26A French Drain encasement in July, 1965. Reconnected the effluent pipeline to the new 216-A-26B French Drain encasement.		

Ref. 5.19

9443210.030
0607 0128116

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>		<u>Fast Designation</u>		<u>Number</u>
French Drain		216-A-26 French Drain 216-A-26A French Drain		216-A-26B
<u>Location</u> 200 East, S.E. Quadrant 115 ft south of the center of the 202-A Bldg. 15 ft south of 216-A-26A French Drain.			<u>Service Dates</u> 7/65 to present	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate)		<u>Reference Drawings</u>	<u>Elevations</u>	
N-39535, W-40208 * N-3307, W-45310		H-2-55036 HW-55770 ST 216-A-26A-26B H-2-3225	Ground 708 ft Water Table 403 ft Site Depth Not Known	
<u>Source and Description of Waste</u>				
Volume unknown. Floor drainage from the 291-A fan house. Low-salt, neutral/basic.				
<u>Description of Facility</u>				
French drain, 4 ft. diameter.				
<u>Radionuclide Content</u> (calculated from discharge data)				
Total Beta: <1 Ci				

93200039

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Last Designation</u>	<u>Number</u>
Crib	--	216-A-27
<u>Location</u> 200 East, S.E. Quadrant. ~700 ft. south of 202-A Bldg. ~800 ft west of Canton Ave.	<u>Service Dates</u> 6/65-7/70	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-39100, W-48118 to N-39100, W-48318	<u>Reference Drawings</u> H-2-57508 H-2-57509	<u>Elevations</u> Ground 719 ft Water Table 402 ft Site Depth Not known
<u>Source and Description of Waste</u> 2.3 x 10 ⁷ liters. Sump waste from 293-A Bldg., the laboratory cell drainage from the 202-A Bldg. and the 291-A-1 stack drainage. Low-salt, neutral/basic.		
<u>Description of Facility</u> Sand filled crib, 200 x 10 ft bottom dimensions.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	97	96.5
Beta, Ci	2.7 x 10 ³	< 159.0
⁹⁰ Sr, Ci	41	33.2
¹⁰⁶ Ru, Ci	63	6.48 x 10 ⁻²
¹³⁷ Cs, Ci	53	42.9
⁶⁰ Co, Ci	<2.7	< .307
U, kg	68	168.0

Ref. 5.21

9413218.000

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>		<u>Fast Designation</u>	<u>Number</u>
Crib		216-A-28 French Drain	216-A-28
<u>Location</u>		<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant 500 ft. North of 202-A, 1250 ft. West of Canton Avenue.		12/58-11/67	Inactive
<u>Site Coordinates</u>	(Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>
N-40362, W-48595		H-2-57617	Ground 690 ft Water Table 405 ft (1967) Site Depth 11 ft

Source and Description of Waste

3 x 10⁴ liters. Waste from 203-A enclosure sumps and heating coil condensate from P-1 through P-4 UNH tanks. Low-salt, neutral/basic.

Description of Facility

One crib, rock structure, 10 ft diameter bottom surface. Deactivation: The effluent pipeline to the crib was blocked north of the 203-A UNH Tank enclosure when the effluent flow rate exceeded the infiltration capacity.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	None	None
Beta, Ci	31	< 3.12 x 10 ⁻²
⁹⁰ Sr, Ci	None	None
¹⁰⁶ Ru, Ci	None	None
¹³⁷ Cs, Ci	None	None
⁶⁰ Co, Ci	None	None
U, kg	632	632.0

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Fast Designation</u>	<u>Number</u>
Crib	216-A-32 Crib	216-A-31
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant ~500 ft south of the center of the 202-A Bldg.	1/63-1-65 7/64-11/66	Inactive
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-39370, W-48290	H-2-57934	Ground 704 ft Water Table 404 ft(1973) Site Depth Not known
<u>Source and Description of Waste</u>		
1.0 x 10 ⁴ liters. <u>Organic waste</u> from the 202-A Bldg. Low-salt, neutral/basic.		
<u>Description of Facility</u>		
Gravel filled crib, 70' ft by 10 ft. Deactivation: "L" cell nozzles to the 241-A-151 Diversion base which routed the effluent to the crib have been blanked.		
<u>Radionuclide Content (calculated from discharge data)</u>		
<u>Radionuclide</u>	<u>At time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	9.0	9.0
Beta, Ci	2.0 x 10 ⁵	< 246.0
⁹⁰ Sr, Ci	2.0	1.42
¹⁰⁶ Ru, Ci	9.5 x 10 ⁴	6.10
¹³⁷ Cs, Ci	150	109.0
⁶⁰ Co, Ci	0.10	1.58 x 10 ⁻²
U, kg	21	20.5

20080216
043200002

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u> Crib		<u>Fast Designation</u>	<u>Number</u> 216-A-32
<u>Location</u> 200 East, S.E. Quadrant 200 East Area. Approximately 300 ft. north-east of 202-A and approximately 700 ft west of Canton Avenue.		<u>Service Dates</u> 1/59-	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-40148, W-47811 to N-40212, W-47782	<u>Reference Drawings</u> H-2-55900 H-2-55901 H-2-56000 H-2-57110	<u>Elevations</u> Ground 697 ft Water Table 404 ft(1973) <u>Site Depth</u> 12 10 ft	
<u>Source and Description of Waste</u> Volume unknown. East crane maintenance facility floor, sink and shower drainage from 202-A.			
<u>Description of Facility</u> Crib, gravel-filled, 70 ft x 8 ft. 70 ft x 8 FT			
<u>Radionuclide Content</u> (calculated from discharge data) <1 Ci Beta			

Ref. 5.24

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u> French Drain		<u>Fast Designation</u> 216-A-33 Dry Well	<u>Number</u> 216-A-33
<u>Location</u> 200 East, S.E. Quadrant ~300 ft south of 202-A, ~1100 ft West of Canton Avenue. Near the S.W. corner of 291-A Bldg.		<u>Service Dates</u> 11/56-7/64	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-39617, W-48310	<u>Reference Drawings</u> H-2-55036	<u>Elevations</u> Ground 716 ft Water Table 402 ft <u>Site Depth</u> Not known	
<u>Source and Description of Waste</u> Volume unknown. Bearing coolant from the 291-A-1 stack electric exhaust fans.			
<u>Description of Facility</u> French drain, 6-ft diameter.			
<u>Radionuclide Content</u> (calculated from discharge data) Total Beta: <1 Ci			

Ref. 5.25

CONTAMINATED LIQUID DISPOSAL SITES

I. SE

<u>Name/Type of Facility</u>	<u>Fast Designation</u>	<u>Number</u>
French Drain	216-A-35 Dry Well	216-A-35
<u>Location</u> 200 East, S.E. Quadrant. 200 East Area, West End of 202-A Bldg. Near 216-A-13	<u>Service Dates</u> 12/63-1/66	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-39800, W-49003	<u>Reference Drawings</u> H-2-55076	<u>Elevations</u> Ground 708 ft Water Table 403 ft Site Depth NA
<u>Source and Description of Waste</u> Volume unknown. Seal cooling water from the air sampler vacuum pumps in the 202-A Bldg. Low-salt, neutral/basic.		
<u>Description of Facility</u> French drain, 6-ft diameter.		
<u>Radionuclide Content</u> (calculated from discharge data) Total Beta: <1 Ci		

Ref. 5.26

CONTAMINATED LIQUID DISPOSAL SITES

I. SE

<u>Name/Type of Facility</u>	<u>Fast Designation</u>	<u>Number</u>
Crib	216-A-36 Crib	216-A-36A
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant 750 ft. south of 202-A Bldg. 1150 ft West of Canton Ave.	9/65-3/66	Inactive
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-39000, W-48525 to N-39105, W-48525	H-2-59805 H-2-59129	Ground 710 ft Water Table 403 ft(1973) Site Depth 25 ft

Source and Description of Waste

1.07 x 10⁶ liters of ammonia scrubber waste from Purex. Low-salt, neutral/basic

Description of Facility

Gravel structure, 100 ft x 11 ft bottom area. Deactivated because of a large discharge of fission products. Concrete dam installed between 216-A-36A and 216-A-36B. Pipeline to 216-A-36 extended into 216-A-36B.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	80	80.0
Beta, Ci	1.5 x 10 ⁵	< 5280.0
⁹⁰ Sr, Ci	1.8 x 10 ³	1320.0
¹⁰⁶ Ru, Ci	3 x 10 ³	5.5
¹³⁷ Cs, Ci	1.5 x 10 ³	1120.0
⁶⁰ Co, Ci	10	1.9
U, kg	145	145.0

9413218.0346

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Fast Designation</u>	<u>Number</u>
Crib	216-A-36 Crib	216-A-36B
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant ~1200 ft south of the 202-A Bldg.	3/66-1972	Inactive
<u>Site Coordinates</u> (Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>
N-38500, W-48525 to N-39000, W-48525	H-2-59129 H-2-59805	Ground 719 ft Water Table 403 ft Site Depth NA

Source and Description of Waste

9.4 x 10⁷ liters. Ammonia scrubber waste from the 202-A Bldg. Low-salt, neutral/basic.

Description of Facility

Gravel-filled crib, 500 ft x 11 ft. bottom dimensions. (See 216A-36A)

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	<180	177.0
Beta, Ci	4.8 x 10 ⁴	< 2050.0
⁹⁰ Sr, Ci	550	455.0
¹⁰⁶ Ru, Ci	6.5 x 10 ³	45.6
¹³⁷ Cs, Ci	<560	463.0
⁶⁰ Co, Ci	<51	< 18.1
²³⁸ U, kg	120	119.0
²³³ U, g		25.6

9413219.0347

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Fast Designation</u>	<u>Number</u>
Crib	216-A-38	216-A-38
<u>Location</u> 200 East, S.E. Quadrant ~600 ft Southwest of 202-A Bldg., ~1500 ft north of 1st St.	<u>Service Dates</u> Never used	<u>Status</u> Inactive
<u>Site Coordinates (Approximate)</u> N-38971, W-49352 to N-39471, W-49352	<u>Reference Drawings</u> H-2-62875	<u>Elevations</u> Ground Water Table Site Depth
<u>Source and Description of Waste</u> Never used.		
<u>Description of Facility</u> Crushed stone-filled, 520 ft x 15 ft bottom dimensions. Never used.		
<u>Radionuclide Content</u> (calculated from discharge data)		

Ref. 5.29

<u>Name/Type of Facility</u>		<u>Fast Designation</u>	<u>Number</u>
Crib		216-A-40 Crib	216-A-39
<u>Location</u> 200 East, S.E. Quadrant		<u>Service Dates</u>	<u>Status</u>
Directly north of 241-AX Tank Farm along Canton Ave.		6/66	Inactive
<u>Site Coordinates</u> (Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>	
N-41860, W-47489 to N-41860, W-47399 N-41930, W-47489 to N-41930, W-47399	H-2-33295	Ground 675 ft Water Table 404 ft Site Depth <i>42</i> Not known	
<u>Source and Description of Waste</u>			
20 liters. Floor drainage from the 241-AX-801-8 Bldg. Low-salt, neutral/basic.			
<u>Description of Facility</u>			
Crib and two trenches filled with gravel and backfilled. 90 ft x 2 ft bottom dimensions.			
<u>Radionuclide Content</u> (calculated from discharge data)			
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>	
Beta; Ci	50	36.4	
¹³⁷ Cs, Ci	25	19.0	
<u>History:</u>			
This site is the result of an unplanned radioactive materials release originating in the 241-AX-801-8 Building.			
(See Attachment)			
Ref. 5.30			

216-A-39 continued

History:

A Process operator, Maintenance instrument man, and a Radiation Monitor were changing out a valve on the 103AX tank recirculator line when highly radioactive waste liquid pressurized in the line and flowed out onto the floor of the instrument building. Dose rates from the spill were greater than 5 R/hr at a distance of 10 feet from the spill.

A trench approximately 3 feet deep was dug from the door of the 801 Building to the brow of the north hill, then over the hill to the flat ground below where it was extended eastward approximately 90 feet. A hole was cut through the back side of the 801 building and a fire hose was inserted to wash the contamination into the trench. The first trench was covered with soil and a second trench, paralleling the first, was dug to receive a second washing. This trench was also covered. Dose rate residue radiation remains in the floor of the building and in the 2 trenches of 216-A-39.

0600000390
9432000016

CONTAMINATED LIQUID DISPOSAL SITES

I. SE

<u>Name/Type of Facility</u>		<u>Past Designation</u>	<u>Number</u>
Trench		216-A-39 Ditch 216-A-40 Ditch	216-A-40
<u>Location</u>		<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant ~500 ft West of 241-AX Tank Farm, ~500 ft South of 7th Ave.		1/68-present	Inactive
<u>Site Coordinates</u> (Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>	
N-41519, W-48209 to N-41868, W-48404	H-2-61979 H-2-63083 H-2-63084	Ground	683 ft
		Water Table	404 ft
		Site Depth	Not known

Source and Description of Waste

9.5 x 10⁵ liters. Diverted cooling water and steam condensate from the 244AR Vault. This is a rubber bag type diverter trench for the recovery of radioactive cooling water that might become contaminated from equipment failures.

Description of Facility

Open trench, 400 ft x 20 ft. — *located at the end of the trench*

Radionuclide Content (calculated from discharge data)

Unknown.

CONTAMINATED LIQUID DISPOSAL SITES

RMO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Last Designation</u>	<u>Number</u>
Crib	--	216-A-41
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant Approximately 600 ft west of 241-AX Tank Farm and approximately 600 ft south of 7th Avenue.	1/68- 1974	Out of service
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-41420, W-48082	H-2-61975 H-2-63084	Ground 683 ft Water Table 405 ft(1973) Site Depth 6 ft
<u>Source and Description of Waste</u>		
Volume unknown. 296-A-13 Stack Drainage. Potentially slightly acidic.		
<u>Description of Facility</u>		
Crib, gravel-filled, 10 ft x 10 ft bottom surface.		
<u>Radionuclide Content (calculated from discharge data)</u>		
<Ci Beta		
<u>History</u>		
<p>The stack drainage piping from the 296-A-13 stack to the 216-A-41 Crib was removed in 1974. The stack drainage was then rerouted to the Vessel seal pot system of the 244AR Building.</p> <p><i># 2 filter - removed real pot.</i></p>		
Ref. 5.33		

9443210.0352

CONTAMINATED WASTE DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Basic Designation</u>	<u>Number</u>
Crib	216-C Crib	216-C-1
<u>Location</u> 200 East, S.E. Quadrant 250 ft South of 2704-C Bldg. 450 ft South of 7th Street (within the Hot Semiworks comp ex.)	<u>Service Dates</u> 1-53 - 1-53 1/53 - - -	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-42069, W-50235	<u>Reference Drawings</u> H-2-4137 H-2-4523	<u>Elevations</u> Ground 689 ft Water Table 405 ft (1973) Site Depth 13 ft
<u>Source and Description of Waste</u> 2.34 x 10 ⁷ liters. High-salt waste cold run waste and process condensate from 201-C (semi-works). High-salt neutral/basic.		
<u>Description of Facility</u> One crib, 23 ft x 8 ft bottom surface, concrete structure.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	
Pu, g	8	
Beta, Ci	1.1 x 10 ⁴	
⁹⁰ Sr, Ci	200	
¹⁰⁶ Ru, Ci	400	
¹³⁷ Cs, Ci	<0.10	
⁶⁰ Co, Ci	<0.10	
U, kg	300	

943218.034

The 218-C-1, C-3, C-4, and C-5 Crib complex along the south fence line of the "Hot Semiworks", 200 East Area, was decontaminated, and the ground surface stabilized against wind erosion and plant root invasion.

The work done was as follows:

- o Bladed off four inches of the ground surface and deposited spoil in the cavity above 216-C-1 Crib.
- o Covered the ground with a four-inch sand pad.
- o Applied ureabor herbicide at the rate of 500 lbs./acre.
- o Installed 10 mil plastic sheeting over entire surface.
NOTE: The plastic sheet was doubled over the area around the tank #71 riser.
- o Installed 12-inch pad of sand over the plastic.
- o The surface stabilized with four inches of pit run gravel.

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u> Dry well.	<u>Past Designation</u> 291-C Dry Well 216-C-2 Dry Well	<u>Number</u> 216-C-2
<u>Location</u> 200 East, S.E. Quadrant Approx. 100 ft southeast of the 291-C Stack. (within the Hot Semi-works complex)	<u>Service Dates</u> 1/53-	<u>Status</u> Active
<u>Site Coordinates</u> N-42300, W-50000	<u>Reference Drawings</u> H-2-4033 H-2-32523	<u>Elevations</u> Ground 681 ft Water Table 402 ft(1973) Site Depth 40 ft
<u>Source and Description of Waste</u> Volume unknown. 291-C stack drainage and the seal water drainage from the stack ventilation filters. Low-salt, neutral/basic.		
<u>Description of Facility</u> Reverse well, 12-in. diameter. <u>Radionuclide Content</u> (calculated from discharge data) <1 Ci Beta		

Ref. 5.36

9413218-0355

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	201-C Leaching Pit	216-C-3
<u>Location</u> 200 East. S.E. Quadrant 400 ft south of 7th Street, 375 ft S.S.E. of 2704-C Bldg. (within the Hot semi-works complex).	<u>Service Dates</u> 1/53-3/54	<u>Status</u> Inactive
<u>Site Coordinates (Approximate)</u> N-42055, W-50390	<u>Reference Drawings</u> H-2-4034 H-2-32523	<u>Elevations</u> Ground 689 ft Water Table 405 ft (1973) <u>Site Depth</u> 10 ft
<u>Source and Description of Waste</u> 5 x 10 ⁶ liters. Acid waste from 201-C, 215-C, 271-C.		

Description of Facility

One crib, gravel pit structure, 50 ft x 10 ft bottom surface.
Deactivation: Pipeline blanked when the crib reached its specific
retention capacity.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>
Pu, g	1
Beta, Ci	200
⁹⁰ Sr, Ci	20
¹⁰⁶ Ru, Ci	10
¹³⁷ Cs, Ci	<0.10
⁶⁰ Co, Ci	<0.10
U, kg	45
²³³ U, g	none

9413218.0357

The 218-C-1, C-3, C-4, and C-5 Crib complex along the south fence line of the "Hot Semiworks", 200 East Area, was decontaminated, and the ground surface stabilized against wind erosion and plant root invasion.

The work done was as follows:

- o Bladed off four inches of the ground surface and deposited spoil in the cavity above 216-C-1 Crib.
- o Covered the ground with a four-inch sand pad.
- o Applied ureabor herbicide at the rate of 500 lbs./acre.
- o Installed 10 mil plastic sheeting over entire surface.
NOTE: The plastic sheet was doubled over the area around the Tank #71 riser.
- o Installed 12-inch pad of sand over the plastic.
- o The surface stabilized with four inches of pit run gravel.

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib		216-C-4
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S. E. Quadrant 375 ft south of 7th Street, 375 ft S.E. of 2704 Bldg. (within the Hot Semiworks Complex).	7/55-5/65	Inactive
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-42060, W-50430	H-2-4010 H-2-4425 H-2-32523	Ground 689 ft Water Table 405 ft(1973) Site Depth 16 ft

Source and Description of Waste

1.7 x 10⁵ liters. Contaminated organic waste from 276-C. Low-salt, neutral basic.

Description of Facility

One crib, 20 ft x 10 ft bottom surface, gravel structure.
Deactivation: Piping to the crib in 276-C was valved out when the specific retention capacity was reached.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>
Pu, g	1
Beta, Ci	120
⁹⁰ Sr, Ci	28
¹⁰⁶ Ru, Ci	15
¹³⁷ Cs, Ci	<0.10
⁶⁰ Co, Ci	<0.10
U, kg	3.4
²³³ U, g	none

944328B.059

The 218-C-1, C-3, C-4, and C-5 Crib complex along the south fence line of the "Hot Semiworks", 200 East Area, was decontaminated, and the ground surface stabilized against wind erosion and plant root invasion.

The work done was as follows:

- o Bladed off four inches of the ground surface and deposited spoil in the cavity above 216-C-1 Crib.
- o Covered the ground with a four-inch sand pad.
- o Applied ureabor herbicide at the rate of 500 lbs./acre.
- o Installed 10 mil plastic sheeting over entire surface.
NOTE: The plastic sheet was doubled over the area around the Tank #71 riser.
- o Installed 12-inch pad of sand over the plastic.
- o The surface stabilized with four inches of pit run gravel.

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-C-5	216-C-5
<u>Location</u> 200 East, S.E. Quadrant 450 ft south of 7th Street, 375 ft S.S.W. of the 2704-C Bldg. (within the Hot Semiworks complex).	<u>Service Dates</u> 3/55-6/55	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-42030, W-50360	<u>Reference Drawings</u> H-2-4010 H-2-4425 H-2-32523	<u>Elevations</u> Ground 649 ft Water Table 405 ft(1973) Site Depth 16 ft

Source and Description of Waste

3.79 x 10⁴ liters. High-salt, cold run waste from 201-C (semi-works).

Description of Facility

One crib, ground structure, 10 ft x 10 ft bottom surface. Deactivation: Piping to crib valved out when the specific retention capacity was reached.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>
Pu, g	1
Beta, Ci	94
⁹⁰ Sr, Ci	10
¹⁰⁶ Ru, Ci	5
¹³⁷ Cs, Ci	<0.10
⁶⁰ Co, Ci	<0.10
U, kg	54

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. SE

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	241-CX Crib	216-C-6
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, S.E. Quadrant 450 ft south of 7th Street, 325 ft south of the 291-C Stack (within the Hot Semiworks Complex).	9/55-9/64	Inactive
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-42015, W-50066	H-2-4425 H-2-35523	Ground 689 ft Water Table 405 ft(1973) Site Depth 16 ft
<u>Source and Description of Waste</u>		
5.3 x 10 ⁵ liters. Process condensate from 201-C; 241-CX vault floor drainage. <u>Acidic.</u>		

Description of Facility

One crib, gravel structure, 20 ft x 20 ft bottom surface.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>
Pu, g	<0.10
Beta, Ci	2 x 10 ³
⁹⁰ Sr, Ci	65
¹⁰⁶ Ru, Ci	25
¹³⁷ Cs, Ci	<0.10
⁶⁰ Co, Ci	<0.10
U, kg	<0.05

290-1176-16
943200-0062

INDEX - VOLUME I 200 EAST AREA
Northwest Quadrant

216-8-12 Crib	I. NW	218-E-2 Burial Ground	I. NW
216-8-35 Trench (covered)	I. NW	218-E-2A Burial Ground	I. NW
216-8-36 Trench (covered)	I. NW	218-E-4 Burial Ground	I. NW
216-8-37 Trench (covered)	I. NW	218-E-5 Burial Ground	I. NW
216-8-38 Trench (covered)	I. NW	218-E-5A Burial Ground	I. NW
216-8-39 Trench (covered)	I. NW	218-E-9 Storage Site	I. NW
216-8-40 Trench (covered)	I. NW	218-E-10 Burial Ground	I. NW
216-8-41 Trench (covered)	I. NW	UN-216-E-2 Unplanned Release	I. NW
216-8-42 Trench (covered)	I. NW	UN-216-E-6 Unplanned Release	I. NW
216-8-43 Crib	I. NW	UN-216-E-8 Unplanned Release	I. NW
216-8-44 Crib	I. NW	UN-216-E-13 Unplanned Release	I. NW
216-8-45 Crib	I. NW		
216-8-46 Crib	I. NW		
216-8-47 Crib	I. NW		
216-8-48 Crib	I. NW		
216-8-49 Crib	I. NW		
216-8-50 Crib	I. NW		
216-8-55 Crib	I. NW		
216-8-57 Crib	I. NW		
216-8-60 Crib	I. NW		
216-8-61 Crib	I. NW		
216-8-62 Crib	I. NW		

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. JW

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-ER-1,2, and 3 Crib 216-ER Crib	216-8-12
<u>Location</u> 200 East, N.W. Quadrant 1000 ft Northwest of 221-8	<u>Service Dates</u> 11/52-12/57 11/67-11/73	<u>Status</u> Deactivated
<u>Site Coordinates</u> (Approximate) N-42972, W-55000 to N-43133, W-55000	<u>Reference Drawings</u> H-2-43027 H-2-43029 H-2-43039 H-2-43046 SK-2-19674	<u>Elevations</u> Ground 697 ft Water Table 404 ft(1973) Site Depth 30 ft

Source and Description of Waste

5.2 x 10⁶ liters. Process condensate from Evaporators in 221-U and 224-U Bldgs. 11/52 to 12/57. Construction waste, 5/67 to 11/67. 221-8 Process condensate, 11/67 to 11/73, (neutralized with limestone). Low-salt, neutral/basic.

Description of Facility

Wooden structure. Bottom surface area 160 ft x 50 ft. Three cribs 16 ft square in gravel bed. Crib collapsed (see RL Occurrence Report 73-82). Following discovery of crib collapse, immediate action was taken to deactivate crib and backfill area to grade.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	370	374.0
Beta, Ci	1.1 x 10 ⁴	<2080.0
⁹⁰ Sr, Ci	<150	< 107.0
¹⁰⁶ Ru, Ci	310	0.276
¹³⁷ Cs, Ci	1.2 x 10 ³	949.0
⁶⁰ Co, Ci	<1.7	< 0.623
U, kg	2.1 x 10 ⁴	20,900.0

(See next page)

AUG 23 1974

DATE

REVISIONS
REVISIONS

B. J. SAUERESSIG

L. J. BRECKE

REFERENCES

1. RADIOACTIVE WASTE DISPOSAL CODES - 171, "GROUND DISPOSAL - TREATING SITES," NUCLEAR ENERGY COMMISSION MANUAL - 16, APPROXIMATE 1957.
2. NRC-1000, "APPROX. ARCHITECTURAL AND CIVIL STANDARDS, 10-1000 (1967), 10-1000 (1967), 10-1000 (1967), 10-1000 (1967).

3. NRC-220, "RADIATION PROTECTION STANDARDS AND CONTROLS, STANDARD NO. 1," PERSONNEL PROTECTION OPERATIONS, SEPTEMBER 12, 1968.
4. ATLANTIC RICHFIELD HANFORD COMPANY OPERATING INSTRUCTION 10-1000, "OUTDOOR RADIATION TESTS"

1 SUMMARY

CONDITIONS FOR DEACTIVATION OF THE 216 - B - 12 CRIB HAVE BEEN SATISFIED AND FUTURE RESPONSIBILITY TRANSFERRED TO TECHNICAL SERVICES

APPROVED:

APPROVED:

TECHNICAL SERVICES SECTION

DATE

MANAGER, OPERATING SECTION

DATE

2 ACTIVATION ZONE RECORD

1. ORIGIN OF MATERIALS INTRODUCED TO THE SITE

U Plant Condensate

B Plant Condensate

2 HISTORY

DATE OF INITIAL USE: Nov. 1952

DATE OF FINAL USE: Nov. 1973

Also called the 216 - ER #1, #2, and #3 Crib.

Received the process condensate from the waste evaporators in the 221 - U and 224 - U Bldgs. from November 1952 to December 1957.

Received the process condensate and construction waste from the 221-B Bldg. from May 1967 to November 1973.

3 ESTIMATE OF RADIOACTIVITY AND CURIE INVENTORY

RADIOACTIVITY

A 0.1

B 3.0

C 3.0

CURIES

A 374 gms 20,000ggs

B 10,000 Bq/gms 2400

C 1000 1000

4 RADIATION SURVEY OF THE ZONE

CONDITION: 1) ALL ZONE SURFACES TO BE LESS THAN 1 MRAD/HR

2) NO MEASURABLE SURFACE CONTAMINATION

< 100 C/A

Ref. 5.46

DATA:

III. DEACTIVATION WORK

IV ZONE IDENTIFICATION

	DATE		DATE
1. PERMANENT MARKERS INSTALLED	7/12/74	2. RADIATION ZONE SIGNS INSTALLED SO AS TO BE VISIBLE FROM ALL AVENUES OF APPROACH TO THE ZONE.	5/15/74
2. FENCE OR CHAIN BARRIER INSTALLED IF ZONE IS SUBJECT TO CAVE - IN.	5/15/74		

REMARKS


Total Beta 270 pico curies/liter
Total Strontium <.24 pico curies/liter
Cesium 30±30 pico curies/liter

Ref. 5.47



CHANGING CONSUMER ATTITUDES, ¹ AND THE CHANGING CONSUMER (1997)

Ref. 5.49

 Atlantic Richfield Hanford Company		FACILITIES CHANGE NOTICE (REF. OPERATING INSTRUCTION 4.3.1.3)		NO 03571	
INITIATED BY <i>H. H. H. Co.</i>		ORGANIZATION <i>FFI</i>	PHONE NO. <i>5-556</i>	PLANT NO. (REFERENCE ONLY) <i>17</i>	
DRAWING(S) AFFECTED	REV. NO.	TITLE, PART, NAME OR DESCRIPTION			
<i>H-2-34525</i>	<i>3</i>	<i>CLOSE FILL LINE 1 - 12-12</i>			
<i>H-2-34524</i>	<i>3</i>	<i>CAP</i>			
DESCRIPTION OF CHANGE (BE AS COMPLETE AS POSSIBLE IN DESCRIBING CHANGE; PLANT LOCATION (CELL, ROOM, AREA, ETC.) SLS. NO. <i>271-13</i>					
<p><i>CUT OFF FILL LINE &</i> <i>CAP WITH CEMENT FOR</i> <i>216-13-12 CRIB--FR--LINE</i></p>					
SAFETY APPROVALS (AS REQUIRED) - INDICATE					
<input type="checkbox"/> NUCLEAR	<input type="checkbox"/> RADIOLOGICAL	<input type="checkbox"/> PROCESS	<input type="checkbox"/> MECHANICAL	<input type="checkbox"/> FIRE SAFETY	<input type="checkbox"/> ENGINEERING
<input type="checkbox"/> PERSONNEL PROTECT.					
REVIEW & APPROVAL (AS REQUIRED)					
AUTHORIZED BY <i>E. G. Hinton</i>		DATE <i>1-22-74</i>	WORK COMPLETED <i>E. G. Hinton</i>	SIGNATURE AND DATE <i>4-26-74</i>	CHECK FOR COMPLETENESS: SIGNATURE AND DATE <i>16 x 12 1/2 4-11-74</i>
FOR DRAFTING OPERATION	DRAFTSMAN	DATE COMPLETED	REMARKS		

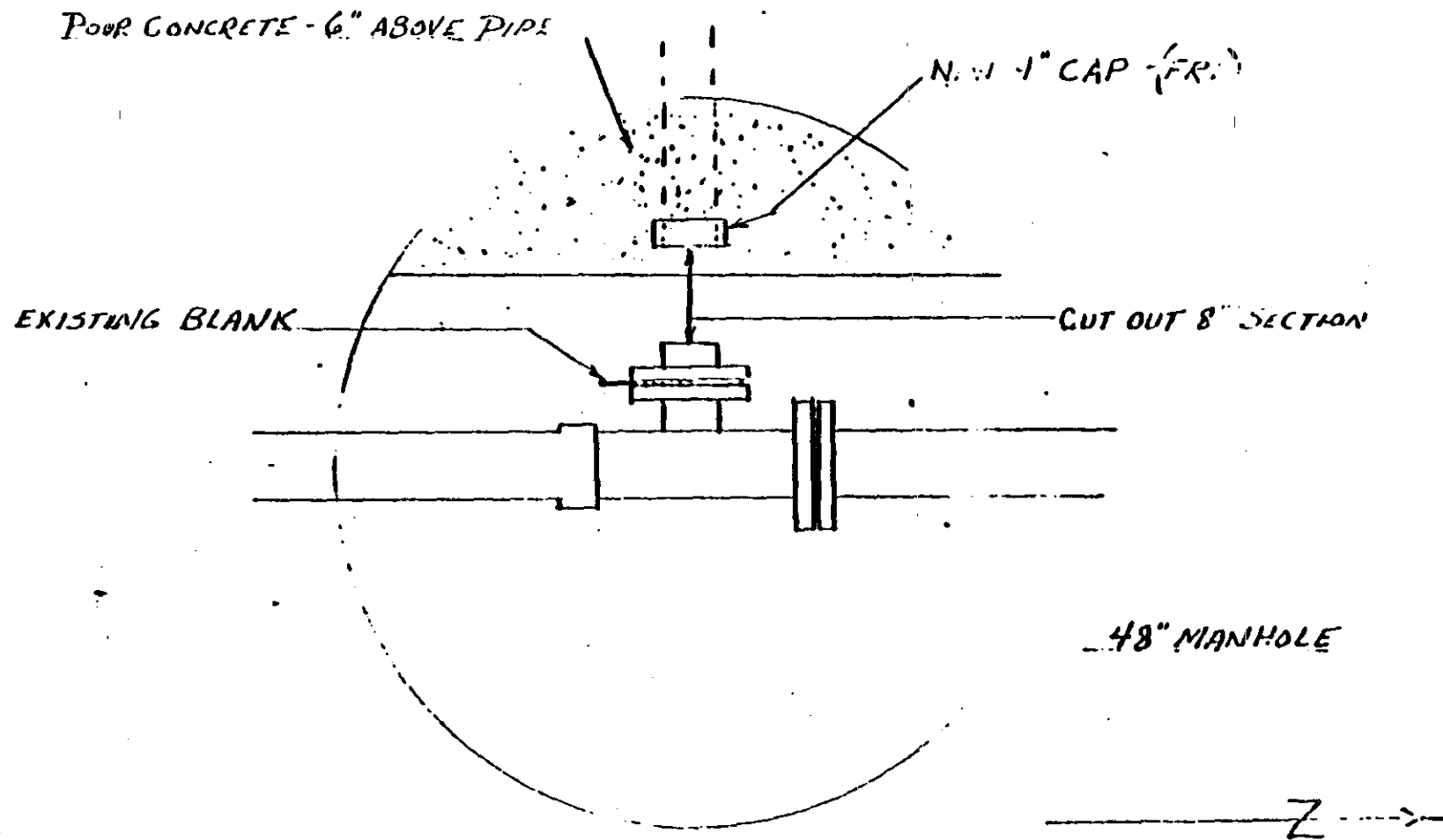
SC-6405-037 (8-71)

DISTRIBUTION (AFTER COMPLETION OF WORK)

COPIES 1 AND 2 DRAFTING UNIT;

COPY 3 PERFORMED BY WORK;

COPY 4 AUTHORIZER'S FILE



PLUG FOR BIR CRIB

W.D.L. - 1/21/74

Harold

3-10-18

All of the actions, ^{described} in the attached letter were completed. I don't know for certain the dates because the job took two years and its been quite some time. If you need more information let me know. I have a folder of surveys, purchase requisitions work orders, plots by Vito's surveyors, etc. etc.

Dick Perton

Date: January 22, 1974
To: A. J. Low
From: R. E. Preston
Subject: 216-8-12 CRIB DEACTIVATION AND TRANSFER OF RESPONSIBILITY

- References:
1. Atomic Energy Commission Manual - RL Appendix 0510-1, July 13, 1967, "Radioactive Waste Disposal Guides - Part 1," "Ground Disposal - Terminating Sites"
 2. HWS-1000, "Hanford Architectural and Civil Standards," AC-3-20 (June 20, 1960), AC-5-2 (October 19, 1959), and AC-5-40 (August 25, 1960)
 3. ARH-220 (unclassified), September 15, 1969, "Radiation Protection Standards and Controls Standard 1," Personnel Protection Operation
 4. Atlantic Richfield Hanford Company Operating Instruction 1.6.5.2, "Outdoor Radiation Zones"

The pertinent AEC Manual Chapters, Atlantic Richfield Hanford Company OPG's and Radiation Protection Standards have been reviewed on the layaway of retired radioactive disposal sites. In this letter the steps are shown for the layaway of 8-12 crib, the list should be used for an order of performance schedule. Step 2 is the only exception, it must be performed before Step 4, but may be completed before Step 1.

1. The risers (vent and gauge wells) should be cut off below the surface and the risers welded shut or flanges welded on and blanks bolted in place. This work can be performed as soon as the liquid level as measured in the gauge well is at or below the 25-foot level as experienced in operation.

The test wells (3) are to be left as at present.

A. J. Low
Page 2
January 22, 1974

The location of these risers and wells is shown on H-2-43029. The gauge well and vent risers are the outside risers in groups of three on each of the three crib sections. The test wells are the center riser in each group.

2. The inlet line has already been blanked off. This was done on November 21, 1973. An FCN has been prepared to show this on drawings H-2-34524 and H-2-34525.

The line to B-12 crib should be cut and the line capped with a plastic cap cemented on the pipe and concrete poured around the end of the pipe. This may be done as soon as material is available.

3. The ground stabilization program should probably be put off until April or May to allow for further settling to avoid repetition of the ground stabilization effort.

The ground stabilization effort should cover an area 60 feet wide, centered on the line running through the test wells. The area should extend 30 feet beyond the outer test wells. This area will be 60 feet wide and 181 feet long, or 10,860 square feet.

The area should be leveled and smoothed, all vegetation removed and any sharp items removed. Two to three inches of sand should be spread over the area. After this, 10 mil plastic sheet should be laid out and weighted down with soil. A solid soil sterilant such as boric acid-type like Ureabor should be sprinkled evenly on top of the plastic. Ureabor can be ordered through Farmer's Exchange in Kennewick. They do not carry it in stock. The area over the plastic should be covered with 18 inches of sand free from any large rocks. Once the sand is laid and leveled, the area should be covered with two-inch minus gravel to a depth of four to six inches.

4. When the soil stabilization is complete, the crib should be marked off with six monuments built according to Hanford Standard AC-5-40. The monuments should be placed at coordinates: N42964XW55030, N42964XW54970, N43056XW54970, N4305XW55030, N43144XW55030, and N43144XW54970.

A. J. Low
Page 3
January 22, 1974

The brass medallions for these posts can be obtained through the Peterson Pattern Works.

Once the posts are in place, Harold Maxfield will stamp the required numbers on the posts.

5. At this time, a radiation survey should be made of the area. The survey information should be recorded on 80-6700-091.1 (7-71).
6. The normal radiation chain fence with radiation signs on posts should be repaired to good condition if it has been damaged during any of the above work.
7. The information required on 80-6700-091.1 (7-71), "Outdoor Radiation Zone Deactivation and Transfer of Responsibility," should be filled out and routed to mailing list on form.
8. At this time, Technical Services will accept custodianship of the crib.

REP:bl

cc: JD Anderson
RB Bixler
DG Harlow
GL Hanson
AJ Low
LM Knights
RP Knight
JH Mathis
WD Schildknecht
A Smith
RM Smithers
File

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. NW

<u>Name/Type of Facility</u> Trench (covered)	<u>Past Designation</u> 241-BX-1 Grave 216-BX-1 Trench 216-B-35 Trench	<u>Number</u> 216-B-35
<u>Location</u> 200 East, N. W. Quadrant 250 ft west of 241-BX Tank Farm, 2650 ft north of B-Plant	<u>Service Dates</u> 2/54-3/54	<u>Status</u> Inactive
<u>Site Coordinates</u> N-45273, W-53850 to N-45273, W-54102	<u>Reference Drawings</u> H-2-2431 SK-2-2408	<u>Elevations</u> Ground 740 ft Water Table 404 ft (1973) Site Depth 10 ft
<u>Source and Description of Waste</u> 1.06 x 10 ⁶ liters. First cycle supernatant waste from 221-8. High-salt, neutral/basic.		
<u>Description of Facility</u> Trench, 252 ft x 10 ft bottom surface. Deactivation: Overground pipeline removed trench backfilled.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	1.2	1.2
Beta, Ci	1800	<732.0
⁹⁰ Sr, Ci	240	130.0
¹⁰⁶ Ru, Ci	230	1.48 x 10 ⁻⁵
¹³⁷ Cs, Ci	430	246.0
⁶⁰ Co, Ci	0.030	1.27 x 10 ⁻³
U, kg	17	16.7
<u>Potential Hazards</u> Radioactive weed growth; Burrowing animals		

Ref. 5.56

913218.0375

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Trench (covered)	241-8X-2 Grave 216-8X-2 Trench 216-8-36 Trench	216-8-36
<u>Location</u> 200 East, N. W. Quadrant	<u>Service Dates</u>	<u>Status</u>
250 ft west of 241-8X Tank Farm, 2750 ft north of B-Plant	3/54-4/54	Inactive
<u>Site Coordinates</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-45323, W-53850 to N-45323, W-54102	H-2-2431 SK-2-2408	Ground 740 ft Water Table 404 ft(1973) Site Depth 10 ft
<u>Source and Description of Waste</u>		
1.94 x 10 ⁶ liters. First cycle supernatant waste from 221-8. High-salt, neutral/basic.		

Description of Facility

Trench, 250 ft x 10 ft bottom surface. Deactivation: Overground pipeline removed trench backfilled.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	0.80	0.80
Beta, Ci	3500	<1390.0
⁹⁰ Sr, Ci	490	269.0
¹⁰⁶ Ru, Ci	470	3.05 x 10 ⁻⁵
¹³⁷ Cs, Ci	770	445.0
⁶⁰ Co, Ci	0.070	2.96 x 10 ⁻³
U, kg	16	16.0

Potential Hazards

Radioactive weed growth;
Burrowing animals

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. NW

<u>Name/Type of Facility</u>		<u>Past Designation</u>	<u>Number</u>
Trench (covered)		241-8X-3 Grave 216-8X-3 Trench 216-8-37 Trench	216-8-37
<u>Location</u> 200 East, N. W. Quadrant		<u>Service Dates</u>	<u>Status</u>
250 ft west of 241-8X Tank Farm, 2850 ft north of B-Plant		8/54-8/54	Inactive
<u>Site Coordinates</u>	<u>Reference Drawings</u>	<u>Elevations</u>	
N-45413, W-53850 to N-45413, W-54102	H-2-2431 SK-2-2408	Ground 663 ft Water Table 404 ft(1973) Site Depth 10 ft	
<u>Source and Description of Waste</u>			
4.32 x 10 ⁶ liters. First cycle <u>bottoms waste</u> from the waste evaporator in 242-8. High-salt, neutral/basic.			
<u>Description of Facility</u>			
Trench, 252 ft x 10 ft bottom surface. Deactivation: Overground pipeline removed trench backfilled.			
<u>Radionuclide Content</u> (calculated from discharge data)			
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>	
Pu, g	2.0	2.0	
Beta, Ci	7000	<3440.0	
⁹⁰ Sr, Ci	16	8.87	
¹⁰⁶ Ru, Ci	500	3.23 x 10 ⁻⁵	
¹³⁷ Cs, Ci	3100	1780.0	
⁶⁰ Co, Ci	1.0	4.22 x 10 ⁻²	
U, kg	3.6	3.63	
<u>Potential Hazards</u>			
Radioactive weed growth; Burrowing animals			

943219-0377

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u> Trench (covered)	<u>Past Designation</u> 241-8X-4 Grave 216-8X-4 Trench 216-8-38 Trench	<u>Number</u> 216-8-38
<u>Location</u> 200 East, N. W. Quadrant 250 ft west of 241-8X Tank Farm, 2950 ft north of B-Plant	<u>Service Dates</u> 7/54-8/54 "	<u>Status</u> Inactive
<u>Site Coordinates</u> N-45503, W-53850 to N-45503, W-54102	<u>Reference Drawings</u> H-2-2431 SK-2-2408	<u>Elevations</u> Ground 660 ft Water Table 404 ft(1973) Site Depth 10 ft
<u>Source and Description of Waste</u> 1.43 x 10 ⁶ liters. First cycle supernatant waste from 221-8. High-salt, neutral/basic.		
<u>Description of Facility</u> Trench, 252 ft x 10 ft bottom surface. Deactivation: Overground pipeline removed and trench backfilled.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	1.2	1.20
Beta, Ci	5800	<2610.0
⁹⁰ Sr, Ci	1900	1030.0
¹⁰⁶ Ru, Ci	560	3.62 x 10 ⁻⁵
¹³⁷ Cs, Ci	510	292.0
⁶⁰ Co, Ci	<0.06	< 2.53 x 10 ⁻³
U, kg	42	42.4
<u>Potential Hazards</u> Radioactive weed growth; Burrowing animals		
Ref. 5.59		

9443218-0378

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. NW

<u>Name/Type of Facility</u> Trench (covered)	<u>Past Designation</u> 241-8X-5 Grave 216-8X-5 Trench 216-8-39 Trench	<u>Number</u> 216-8-39
<u>Location</u> 200 East, N. W. Quadrant 250 ft west of 241-8X Tank Farm, 3050 ft north of B-Plant. East of 218-E-10 Indust. Burial Grounds.	<u>Service Dates</u> 12/53-11/54	<u>Status</u> Inactive
<u>Site Coordinates</u> N-45593, W-53850 to N-45593, W-54102	<u>Reference Drawings</u> H-2-2431 SK-2-2408	<u>Elevations</u> Ground 650 ft Water Table 404 ft(1973) Site Depth 10 ft
<u>Source and Description of Waste</u> 1.47 x 10 ⁶ liters. First cycle supernatant waste from 221-8. High-salt, neutral/basic.		
<u>Description of Facility</u> Trench, 252 ft x 10 ft bottom surface. Deactivation: Overground pipeline removed and trench backfilled.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	1.5	2.51
Beta, Ci	1100	<514.0
⁹⁰ Sr, Ci	23	12.5
¹⁰⁶ Ru, Ci	65	2.69 x 10 ⁻⁶
¹³⁷ Cs, Ci	450	255.0
⁶⁰ Co, Ci	<0.010	< 3.92 x 10 ⁻²
U, kg	5.8	5.80
<u>Potential Hazards</u> Radioactive weed growth; Burrowing animals		

6601076

CONTAMINATED LIQUID DISPOSAL SITES

<u>Name/Type of Facility</u> Trench (covered)	<u>Past Designation</u> 241-8X-6 Grave 216-8X-6 Trench 216-8-40 Trench	<u>Number</u> 216-8-40
<u>Location</u> 200 East, N. W. Quadrant 250 ft west of 241-8Y Tank Farm, 3150 ft north of B-Plant. East of 218-E-10 Indust. Burial Grounds.	<u>Service Dates</u> 4/54-7/54	<u>Status</u> Inactive
<u>Site Coordinates</u> N-45683, W-53850 to N-45683, W-54102	<u>Reference Drawings</u> H-2-2431 SK-2-2408	<u>Elevations</u> Ground 650 ft Water Table 404 ft(1973) Site Depth 10 ft
<u>Source and Description of Waste</u> 1.64 x 10 ⁶ liters. First cycle supernatant waste from 221-8. High-salt, neutral/basic.		
<u>Description of Facility</u> Trench, 252 ft x 10 ft bottom surface. Deactivation: Overground pipeline removed and trench backfilled.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	1.0	1.0
Beta, Ci	1800	<700.0
⁹⁰ Sr, Ci	280	155.0
¹⁰⁶ Ru, Ci	240	1.58 x 10 ⁻⁵
¹³⁷ Cs, Ci	350	203.0
⁶⁰ Co, Ci	<0.020	< 3.45 x 10 ⁻⁴
U, kg	35	35.0
<u>Potential Hazards</u> Radioactive weed growth; Burrowing animals		

Ref. 5.61

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u> Trench (covered)	<u>Past Designation</u> 241-8X-7 Grave 216-8X-7 Trench 216-8-41 Trench	<u>Number</u> 216-8-41
<u>Location</u> 200 East, N. W. Quadrant 250 ft west of 241-8Y Tank Farm, 3250 ft north of 8-Plant. East of 218-8-10 Industrial Burial Grounds	<u>Service Dates</u> 11/54-11/54	<u>Status</u> Inactive
<u>Site Coordinates</u> N-45573, W-53850 to N-45573, W-54102	<u>Reference Drawings</u> H-2-2431 SK-2-2408	<u>Elevations</u> Ground 650 ft Water Table 404 ft(1973) <u>Site Depth</u> 10 ft
<u>Source and Description of Waste</u> 1.44 x 10 ⁶ liters. First cycle supernatant waste from 221-8. High-salt, neutral/basic.		
<u>Description of Facility</u> Trench, 252 ft x 10 ft bottom surface. Deactivation: Overground pipeline removed and trench backfilled.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	0.30	0.30
Beta, Ci	2100	<1040.0
⁹⁰ Sr, Ci	47	26.1
¹⁰⁶ Ru, Ci	130	8.47 x 10 ⁻⁵
¹³⁷ Cs, Ci	890	512.0
⁶⁰ Co, Ci	<0.010	< 4.22 x 10 ⁻⁶
U, kg	7.5	7.5
<u>Potential Hazards</u> Radioactive weed growth; Burrowing animals		

CONTAMINATED LIQUID DISPOSAL SITES

RHQ-CD-673

I. NW

<u>Name/Type of Facility</u>		<u>Past Designation</u>	<u>Number</u>
Trench (covered)		241-BX-8 Grave 216-BX-3 Trench 216-B-42 Trench	216-B-42
<u>Location</u> 200 East, N.W. Quadrant		<u>Service Dates</u>	<u>Status</u>
750 ft west of 241-BX Tank Farm, 2650 ft north of B-Plant, East of 218-E-10 Industrial Burial Grounds.		1/55-2/55	Inactive
<u>Site Coordinates</u>	<u>Reference Drawings</u>	<u>Elevations</u>	
N-45273, W-54152 N-45273, W-54404	H-2-2431 SK-2-2408	Ground 671 ft Water Table 404 ft (1973) Site Depth 10 ft	
<u>Source and Description of Waste</u>			
1.50 x 10 ⁶ liters. Scavenged waste from uranium recovery (TBP solvent extraction) process in 221-U. High-salt, neutral/basic.			
<u>Description of Facility</u>			
Trench, 252 ft x 10 ft bottom surface. Deactivation: Overground pipeline removed and trench backfilled.			
<u>Radionuclide Content</u> (calculated from discharge data)			
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>	
Pu, g	10	10.0	
Beta, Ci	5800	<1360.0	
90Sr, Ci	1100	625.0	
106Ru, Ci	1500	1.93 x 10 ⁻⁴	
137Cs, Ci	96	56.5	
60Co, Ci	10	0.482	
U, kg	680	680.0	
<u>Potential Hazards</u>			
Radioactive weed growth; Burrowing animals			
Ref. 5.63			

94320-0302

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. NW

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-8Y-1 Cavern 216-8Y-1 Crib	216-8-43
<u>Location</u> 200 East, N. W. Quadrant 200 ft north of 241-8Y Tank Farm, 450 ft south of 12th St.	<u>Service Dates</u> 11/54-11/54	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-46332, W-53355	<u>Reference Drawings</u> H-2-2603 H-2-2605	<u>Elevations</u> Ground 623 ft Water Table 406 ft(1973) Site Depth 14 ft

Source and Description of Waste

2.1 x 10⁶ liters. Scavenged waste from uranium recovery (TBP solvent extraction) process in 221-U. High-salt, neutral/basic.

Description of Facility

Crib, 30 ft x 30 ft bottom dimensions, concrete slab roof.
Deactivation: Pipeline to the crib was blanked when the crib reached its specific retention capacity.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	0.5	0.50
Beta, Ci	3500	<1880.0
⁹⁰ Sr, Ci	1400	776.0
¹⁰⁶ Ru, Ci	50	3.23 x 10 ⁻⁶
¹³⁷ Cs, Ci	300	173.0
⁶⁰ Co, Ci	1.0	4.22 x 10 ⁻²
U, kg	14	13.6

Site Characterization Status

The 216-8-43 Crib is the first in a series of seven cribs north of the 241-8Y Tank Farm that received U-Plant high-salt, scavenged waste. These cribs were in service from December 1954 to December 1955 and received a total of 3.4 x 10⁷ liters of waste containing 4.1 x 10⁵ gross beta curies.

216-8-43 continuedSite Char. Status

Four wells were drilled in the vicinity of the BY cribs in 1966 to determine the distribution of radionuclides below these cribs. Well E33-2A drilled at the edge of the 216-8-45 Crib showed the highest ^{137}Cs and ^{90}Sr concentrations. Cesium-137 was first detected at 17 ft (approximate crib bottom) at a concentration of 18.4 $\mu\text{Ci/g}$. The ^{137}Cs concentration increases to a maximum of 28.7 $\mu\text{Ci/g}$ at 20 ft beneath ground surface then rapidly decreases with depth. Several additional concentration peaks occur at lower depths in the soil column but only on the order of 0.001 to 0.0001 of the peak concentration. Strontium-90 concentrations follow the same general pattern with a maximum of 22 $\mu\text{Ci/g}$ at 25 ft. Samples below 75 ft contained less than 2×10^{-3} $\mu\text{Ci/g}$. Data from the other wells showed the same general trend but concentrations were less. It was evident that the quantity of long-lived activity subject to leaching by a moderate rise in the water table is relatively small.

History

The 216-8-43 through 50 cribs are located in a common radiation zone under the hill directly north of the 241-BY Tank Farm. On September 15, 1955 approximately 11,000 gallons of scavenged supernatant radioactive waste overflowed a flush tank and ran over the ground surface near the 216-8-43 Crib. Most of the waste involved was scraped from the ground and pushed into a shallow hole just south and east of the 8-43 Crib. It was then covered with 2 feet of clean soil.

Routine radiation surveys in the early 1970's found radioactive Russian thistle to be growing over the old spill site and other ground surfaces within the radiation zone. Remedial action, which reduced the size of the radiation zone by 50 percent, was started in 1975 and completed in November, 1977. It consisted of the following work:

- o All crib vent risers were cut and blanked off approximately 18" below ground surface.
- o The radioactive buried spill site was removed and all ground surfaces decontaminated by removing radioactive surface soils.
- o The ground surface was smoothed off and covered with a 6" sand pad.
- o Two test strips of ground surface, 10 ft x 100 ft, over the cribs were treated with a tracer element, lithium chloride, to help in determining the effectiveness of the plastic root barrier against future root penetrations.
- o A herbicide, urea borate in dry form, was spread over the radiation zone ground surface at the rate of 500 pounds per acre.

216-8-43 continued

History

- o The surface above and near the cribs was covered with a sheet of 10 mil plastic.
- o The plastic was covered with 6" of sand for a padding against puncture by rocks or other sharp objects, then covered by 12" of top soil.
- o Monitoring well casings were all extended so as to protrude from 12 to 18 inches above ground level.
- o The ground surface was fertilized with 60 pounds of 16-20-0 fertilizer per acre and seeded over the plastic area with 20 lbs. per acre of cheatgrass, and over the remainder of the ground surface of the radiation zone with cheatgrass and Siberian wheatgrass.

CONTAMINATED LIQUID DISPOSAL SITES

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-8Y-2 Cavern 216-8Y-1 Crib	216-8-44
<u>Location</u> 200 East, N. W. Quadrant 300 ft north of 241-8Y Tank Farm, 350 ft south of 12th St.	<u>Service Dates</u> 11/54-3/55	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-46417, W-53355	<u>Reference Drawings</u> H-2-2603 H-2-2605	<u>Elevations</u> Ground 623 ft Water Table 406 ft(1973) Site Depth 14 ft
<u>Source and Description of Waste</u> 5.6 x 10 ⁶ liters. Scavenged waste from uranium recovery (TBP solvent extraction) process in 221-U. High-salt, neutral/basic.		

Description of Facility

One crib, gravel filled, 30 ft x 30 ft bottom surface area, constructed of a concrete slab supported by vertical sections of concrete pipe. Deactivation: The pipeline to the crib was valved out when the specific retention capacity was reached.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	15	15.0
Beta, Ci	2.2 x 10 ⁴	< 4020.0
⁹⁰ Sr, Ci	2900	1620.0
¹⁰⁶ Ru, Ci	5500	6.53 x 10 ⁻⁴
¹³⁷ Cs, Ci	700	109.0
⁶⁰ Co, Ci	5.0	0.228
U, kg	5.3	2.27

Site Characterization Status and History

Refer to 216-8-43

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. NW

<u>Name/Type of Facility</u> Crib	<u>Past Designation</u> 216-8Y-3 Cavern 216-8Y-3 Crib	<u>Number</u> 216-8-45
<u>Location</u> 200 East, N. W. Quadrant 400 ft north of 241-8Y Tank Farm, 250 ft south of 12th St.	<u>Service Dates</u> 4/55-6/55	<u>Status</u> Inactive
<u>Site Coordinates (Approximate)</u> N-46502, W-53355	<u>Reference Drawings</u> H-2-2603 H-2-2605	<u>Elevations</u> Ground 623 ft Water Table 406 ft(1973) Site Depth 14 ft
<u>Source and Description of Waste</u> 4.9 x 10 ⁶ liters. Scavenged waste from uranium recovery (TBP solvent extraction) process in 221-U. High-salt, neutral/basic.		
<u>Description of Facility</u> One crib, gravel filled, 30 ft x 30 ft bottom surface area, constructed of a concrete slab supported by vertical sections of concrete pipe. Deactivation: The pipeline to the crib was valved out when the specific retention capacity was reached.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	10	10.0
Beta, Ci	5.3 x 10 ⁴	< 4880.0
⁹⁰ Sr, Ci	2800	1590.0
¹⁰⁶ Ru, Ci	1.7 x 10 ⁴	2.19 x 10 ⁻³
¹³⁷ Cs, Ci	1500	884.0
⁶⁰ Co, Ci	5.0	0.241
U, kg	6.8	6.8
<u>Site Characterization Status and History</u> Refer to 216-8-43		

Ref. 5.68

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u> Crib	<u>Past Designation</u> 216-8Y-4 Cavern 216-8Y-4 Crib	<u>Number</u> 216-8-46
<u>Location</u> 200 East, N. W. Quadrant 500 ft north of 241-8Y Tank Farm, 150 ft south of 12th St.	<u>Service Dates</u> 9/55-12/55	<u>Status</u> Inactive
<u>Site Coordinates (Approximate)</u> N-46587, W-53355	<u>Reference Drawings</u> H-2-2603 H-2-2605	<u>Elevations</u> Ground 623 ft Water Table 406 ft(1973) Site Depth 14 ft
<u>Source and Description of Waste</u> 6.7 x 10 ⁶ liters. Scavenged waste from uranium recovery (TBP solvent extraction) process in 221-U. High-salt, neutral/basic.		
<u>Description of Facility</u> One crib, gravel filled, 30 ft x 30 ft bottom surface area, constructed of a concrete slab supported by vertical sections of concrete pipe. Deactivation: The pipeline to the crib was valved out when the specific retention capacity was reached.		
<u>Radionuclide Content (calculated from discharge data)</u>		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	20	20.0
Beta, Ci	1.2 x 10 ⁵	<1960.0
⁹⁰ Sr, Ci	1500	852.0
¹⁰⁶ Ru, Ci	2.8 x 10 ⁴	3.61 x 10 ⁻³
¹³⁷ Cs, Ci	200	118.0
⁶⁰ Co, Ci	5	0.241
U, kg	190	191.0
<u>Site Characterization Status and History</u> Refer to 216-8-43		

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. RW

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-8Y-5 Cavern 216-8Y-5 Crib	216-8-47
<u>Location</u> 200 East, N. W. Quadrant	<u>Service Dates</u>	<u>Status</u>
200 ft north of 241-8Y Tank Farm, 450 ft south of 12th St.	9/55-9/55	Inactive
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-46332, W-53499	H-2-2603 H-2-2605	Ground 623 ft Water Table 406 ft(1973) Site Depth 14 ft

Source and Description of Waste

3.7 x 10⁶ liters. Scavenged waste from uranium recovery (TBP solvent extraction) process in 221-U. High-salt, neutral/basic.

Description of Facility

One crib, gravel filled, 30 ft x 30 ft bottom surface area, constructed of a concrete slab supported by vertical sections of concrete pipe. Deactivation: The pipeline to the crib was valved out when the specific retention capacity was reached.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	5.0	5.0
Beta, Ci	4.5 x 10 ⁴	<877.0
⁹⁰ Sr, Ci	620	352.0
¹⁰⁶ Ru, Ci	1.9 x 10 ⁴	2.45 x 10 ⁻³
¹³⁷ Cs, Ci	150	38.4
⁶⁰ Co, Ci	1.0	4.82 x 10 ⁻²
U, kg	6.8	6.8

Site Characterization Status and History

Refer to 216-8-43

9413218.000

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. NW

<u>Name/Type of Facility</u>	<u>Fast Designation</u>	<u>Number</u>
Crib	216-8Y-6 Cavern 216-8Y-6 Crib	216-8-48
<u>Location</u> 200 East, N. W. Quadrant	<u>Service Dates</u>	<u>Status</u>
300 ft north of 241-8Y Tank Farm, 350 ft south of 12th St.	11/55-7/57	Inactive
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-46417, W-53499	H-2-2603 H-2-2605	Ground 623 ft Water Table 406 ft(1973) Site Depth 14 ft
<u>Source and Description of Waste</u>		
4.1 x 10 ⁶ liters. Scavenged waste from uranium recovery (TBP solvent extraction) process in 221-U. High-salt, neutral/basic.		
<u>Description of Facility</u>		
One crib, gravel filled, 30 ft x 30 ft bottom surface area, constructed of a concrete slab supported by vertical sections of concrete pipe. Deactivation: The pipeline to the crib was valved out when the specific retention capacity was reached.		
<u>Radionuclide Content</u> . (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	5.0	5.0
Beta, Ci	6.1 x 10 ⁴	<2010.0
⁹⁰ Sr, Ci	1300	739.0
¹⁰⁶ Ru, Ci	6800	8.76 x 10 ⁻²
¹³⁷ Cs, Ci	450	265.0
⁶⁰ Co, Ci	1.0	4.82 x 10 ⁻²
U, kg	2.3	2.27
<u>Site Characterization Status and History</u>		
Refer to 216-8-43		

Ref. 5.71

943218.000

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. HW

<u>Name/Type of Facility</u>	<u>Last Designation</u>	<u>Number</u>
Crib	216-8Y-7 Cavern 216-8Y-7 Crib	216-8-49
<u>Location</u> 200 East, N. W. Quadrant 400 ft north of 241-8Y Tank Farm, 250 ft south of 12th St.	<u>Service Dates</u> 11/55-12/57	<u>Status</u> Inactive
<u>Site Coordinates (Approximate)</u> N-46502, W-53499	<u>Reference Drawings</u> H-2-2603 H-2-2605	<u>Elevations</u> Ground 623 ft Water Table 406 ft(1973) Site Depth 14 ft

Source and Description of Waste

6.7 x 10⁶ liters. Scavenged waste from uranium recovery (TBP solvent extraction) process in 221-U. High-salt, neutral/basic.

Description of Facility

One crib, gravel filled, 30 ft x 30 ft bottom surface area, constructed of a concrete slab supported by vertical sections of concrete pipe. Deactivation: The pipeline to the crib was valved out when the specific retention capacity was reached.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	15	15.0
Beta, Ci	1.1 x 10 ⁵	<3560.0
⁹⁰ Sr, Ci	2700	1530.0
¹⁰⁶ Ru, Ci	2.4 x 10 ⁴	3.09 x 10 ⁻³
¹³⁷ Cs, Ci	410	242.0
⁶⁰ Co, Ci	5.0	0.241
U, kg	320	318.0

Site Characterization Status and History

Refer to 216-8-43

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u> Crib	<u>Fast Designation</u> 216-8Y-8 Cavern 216-8Y-8 Crib	<u>Number</u> 216-8-50
<u>Location</u> 200 East, N. W. Quadrant ~700 ft north of 241-8Y Tank Farm ~300 ft west of Baltimore Ave.	<u>Service Dates</u> 1/65-1/74	<u>Status</u> Inactive
<u>Site Coordinates (Approximate)</u> N-46502, W-53499	<u>Reference Drawings</u> H-2-2603 H-2-2605	<u>Elevations</u> Ground 622 ft Water Table 404 ft Site Depth 14 ft
<u>Source and Description of Waste</u> 5.9 x 10 ⁷ liters. Waste storage tank condensate from the ITS #1 unit in the 241-8Y Tank Farm.		
<u>Description of Facility</u> Crib, concrete slab over pipe, 30 ft x 30 ft bottom dimension.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	<2.4 x 10 ⁻¹	< 0.239
Beta, Ci	241	< 140.0
⁹⁰ Sr, Ci	<6	< 4.58
¹⁰⁶ Ru, Ci	11	5.05 x 10 ⁻³
¹³⁷ Cs, Ci	88	67.3
⁶⁰ Co, Ci	<3.3 x 10 ⁻¹	< 7.61 x 10 ⁻²
U, kg	<2.9 x 10 ⁻¹	< 0.285
<u>Site Characterization Status and History</u> Refer to 216-8-43 for History		
Ref. 5.73		

200-012616
9413210.002

CONTAMINATED LIQUID DISPOSAL SITES

RMO-CD-673

I. NW

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib		216-8-55
<u>Location</u> 200 East, N.W. Quadrant Approximately 800 ft west of 221-8	<u>Service Dates</u> 9/67-	<u>Status</u> Active
<u>Site Coordinates</u> N-42497, W-54810 to N-42920, W-55431	<u>Reference Drawings</u> H-2-60330 SK-2-19674	<u>Elevations</u> Ground 700 ft Water Table 400 ft(1973) Site Depth 6-8 ft
<u>Source and Description of Waste</u> 6.0 x 10 ⁸ liters as of 12/31/73. Steam condensate from 221-8. Low-salt, neutral/basic.		
<u>Description of Facility</u> Crib, gravel-filled, 750 ft x 10 ft bottom dimension.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	<0.43	< 0.552
Beta, Ci	1.4 x 10 ²	<54.5
⁹⁰ Sr, Ci	<7.2 x 10 ⁰	< 9.53
¹⁰⁶ Ru, Ci	<1.4 x 10 ⁰	< 0.19
¹³⁷ Cs, Ci	2.0 x 10 ¹	17.7
⁶⁰ Co, Ci	<3.2 x 10 ⁻¹	< 0.252
U, kg	<3.9 x 10 ⁰	< 6.71

36087616
9432180093

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u>	<u>Last Designation</u>	<u>Number</u>
Crib	216-8-57	216-8-57
<u>Location</u> 200 East, N.W. Quadrant Near the northwest corner of 241-8Y Tank Farm	<u>Service Dates</u> 2/68-6/73	<u>Status</u> Inactive
<u>Site Coordinates</u> N-46160, W-53775 N-46360, W-53775	<u>Reference Drawings</u> H-2-62406	<u>Elevations</u> Ground 625 ft Water Table 394 ft Site Depth 10 ft (minimum)
<u>Source and Description of Waste</u> 8.4 x 10 ⁷ liters (as of 12/31/73). Waste storage tank condensate from the ITS #2 Unit in the 241-8Y Tank Farm.		
<u>Description of Facility</u> Crib, gravel-filled, 200 ft x 15 ft bottom dimension.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/78</u>
Pu, g	$< 1.9 \times 10^{-1}$	< 0.137
Beta, Ci	8.4×10^2	< 580.0
⁹⁰ Sr, Ci	3.2×10^0	2.47
¹⁰⁶ Ru, Ci	8.7×10^0	2.23×10^{-2}
¹³⁷ Cs, Ci	3.7×10^2	299.0
⁶⁰ Co, Ci	1.4×10^{-1}	< 3.94
U, kg	8.9×10^{-1}	< 0.89

Ref. 5.75

944320 0000 1600 0 20116

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u>	<u>Fast Designation</u>	<u>Number</u>
Crib	216-8-60 Crib	216-8-60
<u>Location</u> 200 East, N. W. Quadrant	<u>Service Dates</u>	<u>Status</u>
The crib is under the floor of the north-east corner of the 225-8 Building.	11/67-11/67	Inactive
<u>Site Coordinates</u> (Approximate)	<u>Reference Drawings</u>	<u>Elevations</u>
N-42573, W-54178 to N-42583, W-54178	H-2-34303	Ground 690 ft Water Table 405 ft(1973) Site Depth 40 ft
<u>Source and Description of Waste</u>		
1.89 x 10 ⁴ liters. Cell cleanout solid and liquid waste from the 24-inch sewer in 221-8. Low-salt, neutral/basic.		
<u>Description of Facility</u>		
Two cribs, 8-ft diameter caissons, 16-ft long, bottom at depth of 40 ft. Deactivation: Tops of the caissons were grouted with concrete to seal in the waste; the 24-in. sewer was plugged at the west end of 221-8. The site is now (5/75) covered by the 225-8 Encapsulation Facility.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/75</u>
Pu, g	0.080	0.08
Beta, Ci	1600	<19.9
¹³⁷ Cs, Ci	8.0	6.21
U, kg	720	727.0

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-8-61 Crib	216-8-61
<u>Location</u> 200 East, N. W. Quadrant ~500 ft northwest of 241-8Y Tank Farm ~200 ft south of 12th Street	<u>Service Dates</u> Never used	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-46650, W-54175 to N-46650, W-54350	<u>Reference Drawings</u> H-2-34522 H-2-34523	<u>Elevations</u> Ground 663 ft Water Table 404 ft <u>Site Depth</u>
<u>Source and Description of Waste</u> Future use: To receive waste storage tank condensate from ITS #1 Unit in the 241-8Y Tank Farm.		
<u>Description of Facility</u> Gravel-filled, 1750 ft ² bottom surface area.		

Ref. 5.77

943209.0396

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Crib	216-8-62	216-8-62
<u>Location</u> 200 East, N.W. Quadrant Approximately 1500 ft northwest of 221-8	<u>Service Dates</u> 11/73-	<u>Status</u> Active
<u>Site Coordinates</u> N-43580, W-54995 to N-43934, W-55349	<u>Reference Drawings</u> H-2-34524 H-2-34525	<u>Elevations</u> Ground 697 ft Water Table 404 ft (1973) Site Depth ~10 ft
<u>Source and Description of Waste</u> 1.9 x 10 ⁶ liters as of 12/31/73. B Plant process condensate.		
<u>Description of Facility</u> Crib, gravel-filled. 500 ft x 10 ft bottom dimension.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 6/30/79</u>
Pu, g	8.4 x 10 ⁻⁴	0.379
Beta, Ci	1.9	<140.0
⁹⁰ Sr, Ci	0.31	19.1
¹⁰⁶ Ru, Ci	<1.8 x 10 ⁻²	< 0.629
¹³⁷ Cs, Ci	0.33	33.9
⁶⁰ Co, Ci	<8.3 x 10 ⁻⁴	<449.0
U, kg	<1.9 x 10 ⁻²	< 2.75

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Burial Ground	300 East/ Industrial Waste No. 02	218-E-2
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, N.W. Quadrant About 2,000 ft north of B-Plant.	1945-1953	Inactive
<u>Site Coordinates</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-44827, W-53426	H-2-2479	Ground 669 ft
N-44395, W-53426	H-2-55534	Water Table 404 ft(1973)
N-44395, W-53950		Site Depth 15 ft
N-44827, W-53950		

Source and Description of WasteFailed equipment and industrial waste (approximately 3.2×10^5 ft³).Description of Facility 2.3 acres. Ref: Ltr. - Rockwell 1/09/80 #65421-80-005

Backfilled trenches.

Surface area 2.98×10^5 ft².Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Burial</u>	<u>As of 9/30/78</u>
U, g	3.0×10^5	3.0×10^5
Pu, g	8.0×10^2	3.0×10^2
Total		
Beta, Ci	2.5×10^4	2.06×10^3
⁹⁰ Sr, Ci	5.0×10^2	253.0
¹⁰⁶ Ru, Ci	1.1×10^3	1.12×10^{-5}
¹³⁷ Cs, Ci	5.3×10^2	253.0

NOTE:A total of ^{TEN} ~~seven~~ burial trenches are shown on print # H-2-2479.

An inspection of the burial grounds 2/21/78 disclosed some caving over all trenches, and ground surface contamination on a number of tumbleweeds near the north end of 218-E-9.

Sunken ground surfaces over the centerlines of the various trenches plus the vegetation growth patterns show the true location of the burial trenches in burial grounds E-2, E-5, E-9 to be different than those drawn on Print H-2-55534.

See Attachments

943213.0398

Burial Ground : 218-E-2

Extensive research work was done during the year 1979 to determine the locations of all burial trenches within the bounds of the 218-E-5, 218-E-5A, 218-E-2 and 218-E-9 Burial Grounds radiation zone. The work included viewing aerial photographs and construction prints, analyzing plant growth patterns, and the load testing of the ground surface.

Four previously unrecorded sites were identified: (See attached map, Figure A.2, Burial Grounds 218-E-2, E-2A, E-5, E-5A, and E-9)

#1 Site Referred to as the 202-A, L-Cell Burial Package. It consisted of four very large burial boxes. The burial location is shown as a 100 foot by 120 foot rectangular area within the 218-E-5A Burial Ground. The D-2 Column from Purex K Cell was also buried here.

#2 Site Multiple trenches running north and south in Burial Ground 218-E-5. It has been stabilized as a single trench.

#4 Site A long trench (423') running east and west along the north side of 218-E-2 Burial Ground.

#5 Site A long trench (423') parallel and adjacent to Site #4 above.

Burial Ground: 218-E-2

Fiscal year ground surface stabilization work within the 218-E-2 Burial Ground was done over trenches #3, 4, 5, 6, 7, 8, 9, 10, 11, and 12. (See map attachment.) Trenches 5, 6, 7, 10, and 12 were so close together they were treated as a single work area. Trenches 9 and 11 were also treated as a single work area.

The work consisted of load testing the ground surface for subterranean voids by driving over the ground with a 40-ton vehicle, removing vegetation and radioactive contamination from the ground surface, placing 1 foot of fill dirt over the burial trenches and seeding the prepared surfaces with cheatgrass.

Details of Cheatgrass Seeding

- o Broadcast seed at rate of 20-25 lbs/acre.
- o Cover seed with a drag.
- o Cover with wheat straw mulch at the rate of two tons mulch/acre (approximately 60 bales of straw).
- o Apply amonium sulphate 21-0-0 fertilizer at the rate of 100 to 200 lbs. per acre.
- o Water with water-truck at the rate of 6500 to 7500 gals/acre. Repeat watering after one week.

The ground surfaces between the seeded trenches were stabilized against weather erosion with a three- to six-inch covering of bank run gravel. The gravel covering will be treated with ureabor herbicide at a rate of 500 lbs/acre.

A total of 9,000 yds³ of dirt was used in the 218-E-5, 5A, 2, and 9 Burial Ground complex for fill material and seed bedding. Three thousand yards of gravel were spread between the trenches.

TABLE 4 218-E-2, 2A, 5, 5A & 9 STATUS

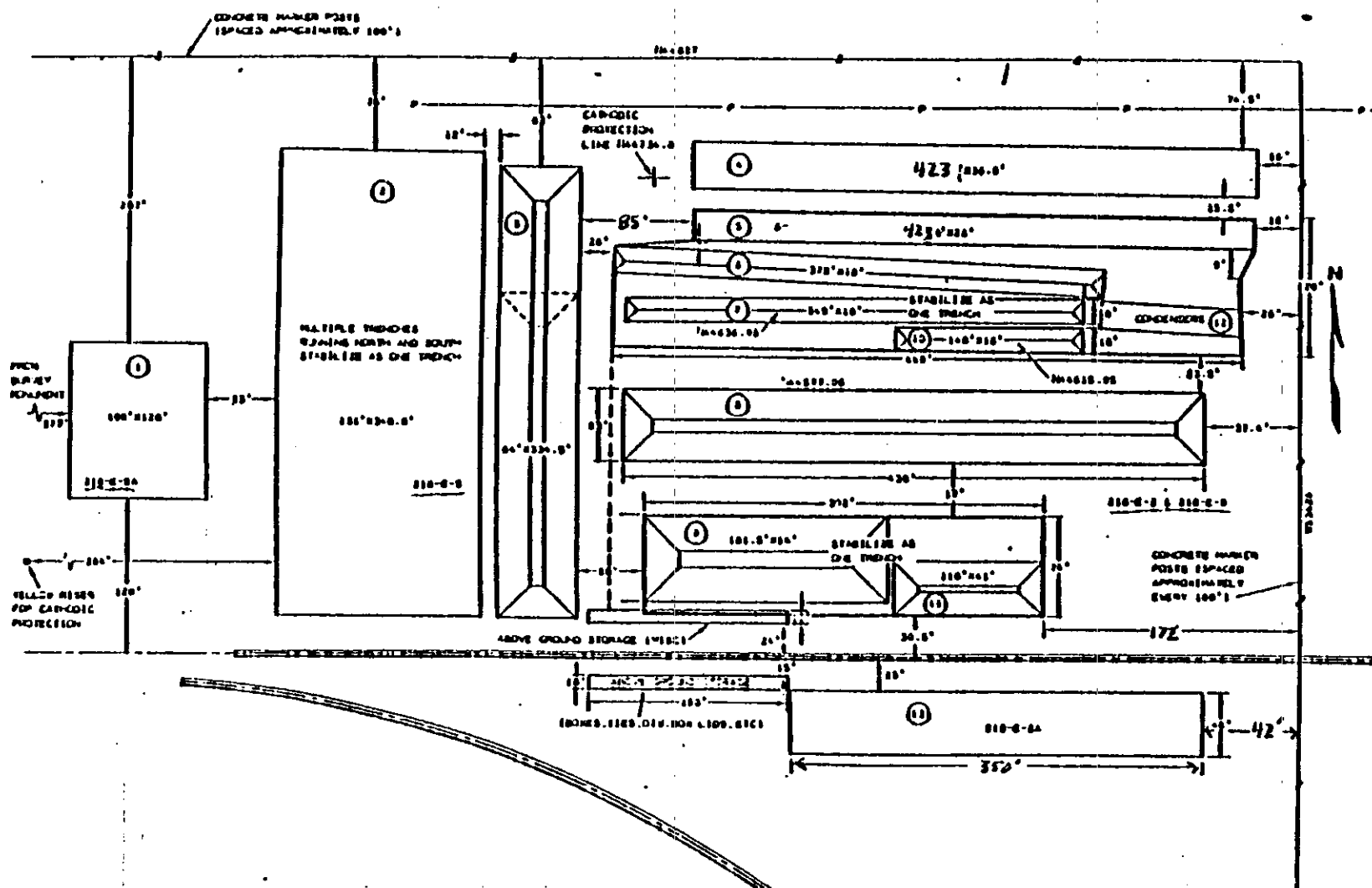
TRENCH NO.	SOIL DEPTH (NO BIOBARRIERS)	REVEGETATION SPECIES
1	1'	To Be Completed FY '80
2	1'	To Be Completed BY '80
3	1'	Cheatgrass
4	1'	Cheatgrass
5, 6, 7, 10, 12	1'	Cheatgrass
8	1'	Cheatgrass
9, 11	1'	Cheatgrass
13	3"-6"	To Be Completed FY '80

SUPPORTING DOCUMENT

Number
U0101EK0101

00

12



Reference: H-2-2479

FIGURE A.2: BURIAL GROUNDS 218-E-2, 2A, 5, 5A, AND 9

Ref. 5.83

4400 072 1 10 1 99

CONTAMINATED LIQUID DISPOSAL SITES

I. NW

<u>Name/Type of Facility</u>	<u>Past Designation</u>	<u>Number</u>
Storage Site	Regulated Equipment Storage Site No. 02A	218-E-2A
<u>Location</u> 200 East, N. W. Quadrant About 14,00 ft north of B-Plant.	<u>Service Dates</u> Unknown	<u>Status</u> Inactive
<u>Site Coordinates</u> N-43827, W-53426 N-44395, W-53426 N-44395, W-54225	<u>Reference Drawings</u> H-2-34761 H-2-2477	<u>Elevations</u> Ground 681 ft Water Table 405 ft(1973) Site Depth NA
<u>Source and Description of Waste</u> Regulated equipment.		
<u>Description of Facility</u> Aboveground storage.		
<u>Radionuclide Content</u> (calculated from discharge data) NA		
<p><u>NOTE:</u></p> <p>Print H-2-2479 shows the outline of a trench 46 feet wide along the north boundary of 218E-2A (a later designation) Burial Ground or above ground storage site.</p> <p>Print H-2-55534 also shows this trench at coordinates N-44332, W-53812, N-44332, W-53468; but the trench is improperly drawn on the print. The centerline N-44332 is shown south of a post at N-44327. However, it still falls within the area later designated as the 216-E-2A Burial Ground.</p> <p>There are no records or burial inventories available at this writing to indicate the 216-E-2A site was ever used as a burial ground. It more properly should be designated as a regulated equipment above ground storage site. The 218-E-2A designation should be dropped.</p> <p>2/21/78 - An inspection of the burial trench in 218-E-2A, south of the railroad track, disclosed a number of sink holes along the center line of the trench, indicating the trench had been dug and used for dry waste burials.</p>		
(See Attachment)		

943218.003

Burial Ground: 218-E-2A

During the summer of 1979, a number of loads of dirt were hauled in and dumped over the burial trench in 218-E-2A Burial Ground. This fill material brought the surface of the trench to ground level. Future plans for fiscal year 1980 include stabilization of the ground surface of this trench.

CONTAMINATED SOLIDS STORAGE AND BURIAL SITES

I. NW

<u>Name/Type of Facility</u>		<u>Last Designation</u>	<u>Number</u>
Burial Ground		200 East/Minor Construction No. 4	218-E-4
<u>Location</u>		<u>Service Dates</u>	<u>Status</u>
200 East, N.W. Quadrant About 1,300 ft north of B-Plant.		2/55-1956	Inactive
<u>Site Coordinates</u>		<u>Reference Drawings</u>	<u>Elevations</u>
N-43757, W-53575		H-2-31269	Ground ~681 ft
N-43666, W-53700		H-2-34761	Water Table ~404 ft (1973)
N-44175, W-54170			Site Depth NA
N-44300, W-54150			

Source and Description of WasteRepair and construction waste (approximately 5.6×10^4 ft³).Description of FacilityBackfilled trenches, surface area: 1.56×10^5 ft².Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Burial</u>	<u>As of 9/30/78</u>
U, g	1.0×10^3	1.0×10^3
Pu, g	10	10.
Total Beta, Ci	10	4.67
⁹⁰ Sr, Ci	0.20	0.112
¹⁰⁶ Ru, Ci	0.43	4.66×10^{-3}
¹³⁷ Cs, Ci	0.21	0.124

NOTE:

The number of trenches is not known.

CONTAMINATED SOLIDS STORAGE AND BURIAL SITES

<u>Name/Type of Facility</u>	<u>As-Designation</u>	<u>Number</u>
Burial Ground	200 East/Industrial Waste No. 05	218-E-5
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, N.W. Quadrant About 1,850 ft north of B Plant.	1954, 1955, 1956	Inactive
<u>Site Coordinates</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-44827, W-53950	H-2-31259	Ground 671 ft
N-44400, W-53950	H-2-55534	Water Table 404 ft(1973)
N-44400, W-54177	H-2-34761	Site Depth 15 ft
N-44827, W-54177	H-2-2479	

Source and Description of Waste

Failed equipment and industrial waste (approximately $1.1 \times 10^5 \text{ ft}^3$).

Description of Facility 2.3 acres. Ref: Ltr. - Rockwell 1/09/80 #65421-80-005

Backfilled trenches, surface area: $1.02 \times 10^5 \text{ ft}^2$.

Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Burial</u>	<u>As of 9/30/78</u>
U, g	1.0×10^5	1.2×10^5
Pu, g	6.2×10^2	520.
Total Beta, Ci	7.5×10^3	352.0
^{90}Sr , Ci	1.5×10^2	64.7
^{106}Ru , Ci	3.2×10^2	4.65×10^{-5}
^{137}Cs , Ci	1.6×10^2	93.3

NOTE:

Print H-2-2479 shows the location of ~~one~~ trench having been dug in the 218-E-5 Burial Ground.

The locations of the trenches in this burial ground, as indicated by sink holes and weed growth patterns along the length of the trenches, is different than locations shown on Print H-2-55534.

Burial Ground : 218-E-5

Extensive research work was done during the year 1979 to determine the locations of all burial trenches within the bounds of the 218-E-5, 218-E-5A, 218-E-2 and 218-E-9 Burial Grounds radiation zone. The work included viewing aerial photographs and construction prints, analyzing plant growth patterns, and the load testing of the ground surface.

Four previously unrecorded sites were identified: (See attached map, Figure A.2, Burial Grounds 218-E-2, E-2A, E-5, E-5A, and E-9)

#1 Site Referred to as the 202-A, L-Cell Burial Package. It consisted of four very large burial boxes. The burial location is shown as a 100 foot by 120 foot rectangular area within the 218-E-5A Burial Ground. The D-2 Column from Purex K Cell was also buried here.

#2 Site Multiple trenches running north and south in Burial Ground 218-E-5. It has been stabilized as a single trench.

#4 Site A long trench (423') running east and west along the north side of 218-E-2 Burial Ground.

#5 Site A long trench (423') parallel and adjacent to Site #4 above.

Burial Ground: 218-E-5

Fiscal year 1979 ground surface stabilization work within the 218-E-5 Burial Ground was confined to a rectangular area 131 feet by 340.5 feet containing multiple burial trenches running north and south.

The work consisted of load testing the ground surface for subterranean voids by driving over the ground with a 40-ton vehicle, marking the site location with steel posts, removing vegetation and radioactive contamination from the ground surface, and establishing a one foot deep soil seed bed over the entire area. Drought resistant grasses will be seeded in FY1980.

(See Table 4 Attachment)

TABLE 4 218-E-2, 2A, 5, 5A & 9 STATUS

TRENCH NO.	SOIL DEPTH (NO BIOBARRIERS)	REVEGETATION SPECIES
1	1'	To Be Completed FY '80
2	1'	To Be Completed BY '80
3	1'	Cheatgrass
4	1'	Cheatgrass
5, 6, 7, 10, 12	1'	Cheatgrass
8	1'	Cheatgrass
9, 11	1'	Cheatgrass
13	3"-6"	To Be Completed FY '80

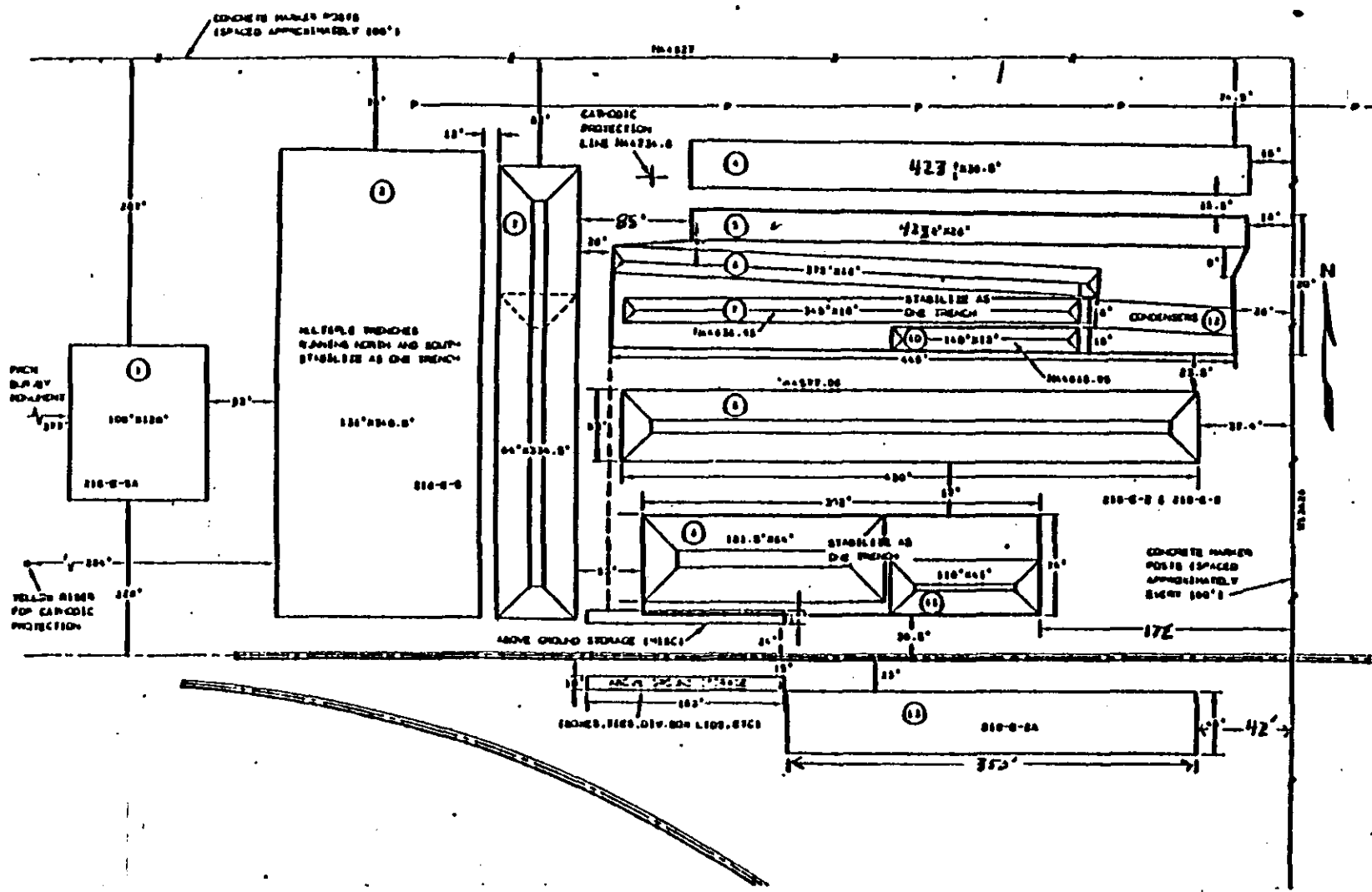
9413218.0440

SUPPORTING DOCUMENT

Number
U0101EK0101

Rev. No.
00

Page
12



Reference: H-2-2479

FIGURE A.2: BURIAL GROUNDS 218-E-2, 2A, 5, 5A, AND 9

Ref. 5.91

A 4400 012 1 IN 3/8"

CONTAMINATED SOLIDS STORAGE AND BURIAL SITES

I. NW

<u>Name/Type of Facility</u>	<u>Last Designation</u>	<u>Number</u>
Burial Ground	200 East/Industrial Waste No. 05A	218-E-5A
<u>Location</u>	<u>Service Dates</u>	<u>Status</u>
200 East, N.W. Quadrant About 1,850 ft north of B Plant adjacent to and west of 218-E-5.	1956-1957-1958-1959	Inactive
<u>Site Coordinates</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-44827, W-54177	H-2-55534	Ground ~671 ft
N-44400, W-54177	H-2-34761	Water Table ~404 ft(1973)
N-44400, W-54609		Site Depth ~15-25 ft
N-44827, W-54609		

Source and Description of WasteFailed equipment and industrial waste (approximately 2.2×10^5 ft).Description of Facility 3.4 acres. Ref: Ltr. Rockwell 1/09/80 #65421-80-005Backfilled trenches, surface area: 2.27×10^5 x ft².Radionuclide Content (calculated from discharge data)

<u>Radionuclide</u>	<u>At Time of Burial</u>	<u>As of 9/30/78</u>
U, g	1.2×10^5	1.2×10^5
Pu, g	1.4×10^3	1.4×10^3
Total Beta, Ci	1.7×10^4	327.
⁹⁰ Sr, Ci	3.3×10^2	199.0
¹⁰⁶ Ru, Ci	7.1×10^2	6.53×10^{-4}
¹³⁷ Cs, Ci	3.5×10^2	219.0

NOTE:

Unable to locate any print showing location of burial trenches in this burial ground.

Burial Ground : 218-E-5A

Extensive research work was done during the year 1979 to determine the locations of all burial trenches within the bounds of the 218-E-5, 218-E-5A, 218-E-2 and 218-E-9 Burial Grounds radiation zone. The work included viewing aerial photographs and construction prints, analyzing plant growth patterns, and the load testing of the ground surface.

Four previously unrecorded sites were identified: (See attached map, Figure A.2, Burial Grounds 218-E-2, E-2A, E-5, E-5A, and E-9)

#1 Site Referred to as the 202-A, L-Cell Burial Package. It consisted of four very large burial boxes. The burial location is shown as a 100 foot by 120 foot rectangular area within the 218-E-5A Burial Ground. The D-2 Column from Purex K Cell was also buried here.

#2 Site Multiple trenches running north and south in Burial Ground 218-E-5. It has been stabilized as a single trench.

#4 Site A long trench (423') running east and west along the north side of 218-E-2 Burial Ground.

#5 Site A long trench (423') parallel and adjacent to Site #4 above.

Burial Ground: 218-E-5A continued

Fiscal year 1979 stabilization work within the 218-E-5A Burial Ground was confined to a 100 foot by 120 foot rectangular area above the burial sites of the Purex L-Cell burial package and the "2-D" column from Purex K Cell.

The work consisted of load testing the ground surface for subterranean voids by driving over the ground with a 40-ton vehicle, marking the site location with steel posts, removing vegetation and radioactive contamination from the ground surface, and establishing a one foot deep soil seed bed over the entire area. Drought resistant grasses will be seeded in FY1980.

See Table 4 Attachment

TABLE 4 218-E-2, 2A, 5, (5A) & 9 STATUS

TRENCH NO.	SOIL DEPTH (NO BIOBARRIERS)	REVEGETATION SPECIES
1	1'	To Be Completed FY '80
2	1'	To Be Completed BY '80
3	1'	Cheatgrass
4	1'	Cheatgrass
5, 6, 7, 10, 12	1'	Cheatgrass
8	1'	Cheatgrass
9, 11	1'	Cheatgrass
13	3"-6"	To Be Completed FY '80

Furn Purep EGP Disposal Records

11/21/56 - 1 BOX - IND #5 South End 11/20/56, 5
 * 3/19/56 1 Remedy - West trend #5 Buid Ground (1)
 * 6/12/56 1 Box - " " #5 " " 5
 4/11/57 1 Box - South end #5 " " 3
 3/24/58 1 Cell package 5A } 2 (10.00) #3
 3/24/58 2D Cell (Kew) 5A }

* THIS PROVES THAT THE 5A BUIOL GROUND
 WAS USED IN 1956 vice FIRST USE IN
 1958 AS STATED BY A. F. ROBERTS DATA.

Ed Hansen

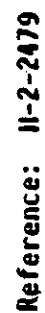
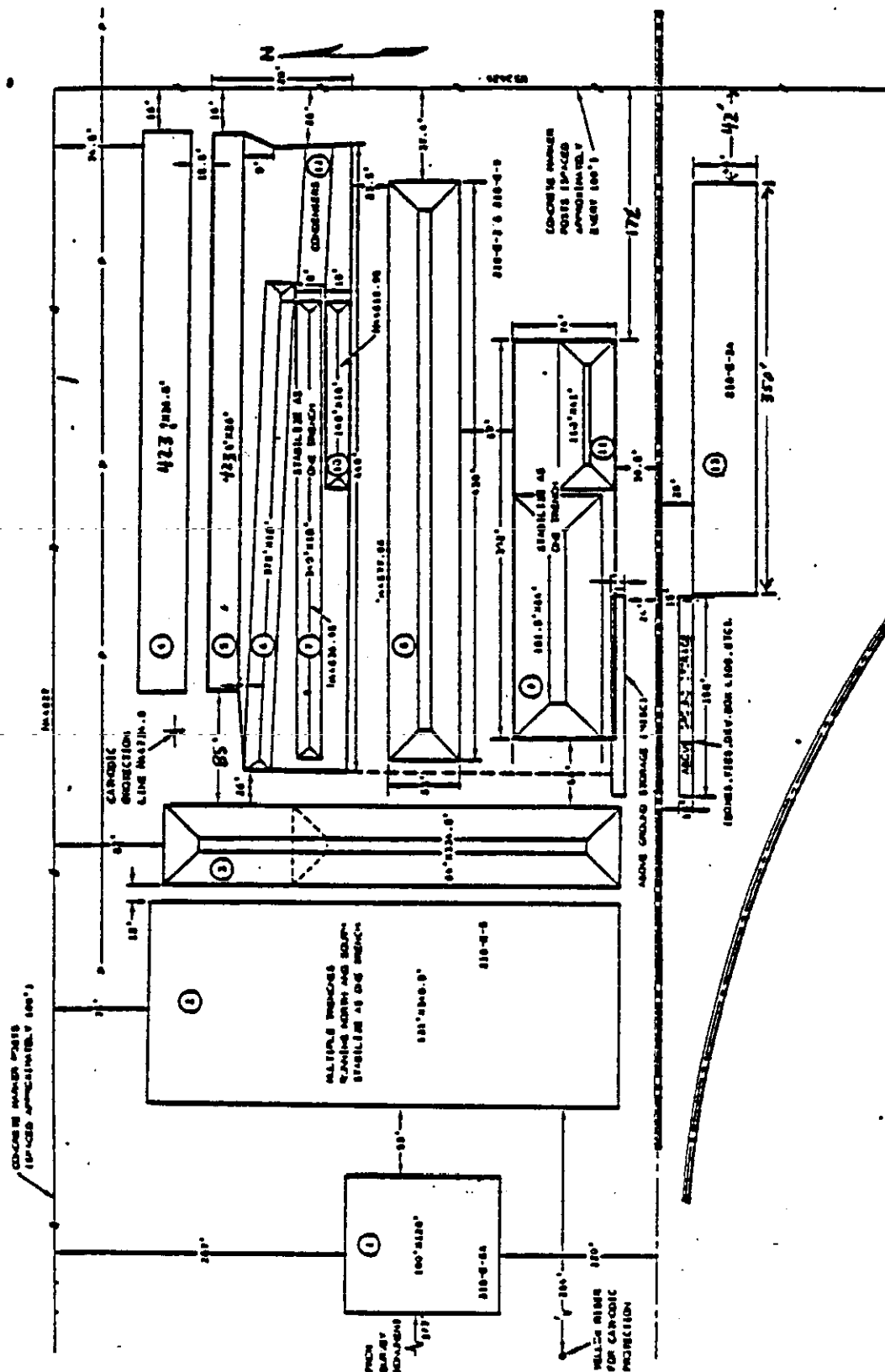


FIGURE A.2: BURIAL GROUNDS 21B-E-2, 2A, 5, 5A, AND 9

CONTAMINATED SOLIDS STORAGE AND BURIAL SITES

I. NW

<u>Name/Type of Facility</u> Storage Site	<u>Last Designation</u> 200 East/Regulated Equipment Storage Site No. 09	<u>Number</u> 218-E-9
<u>Location</u> 200 East, N.W. Quadrant About 2000 ft north of B Plant. East of 218-E-2 Burial Grounds.	<u>Service Dates</u> 1958	<u>Status</u> INACTIVE
<u>Site Coordinates</u> N-44395, W-53426 N-44827, W-53426 N-44827, W-53516 N-44395, W-53516	<u>Reference Drawings</u> H-2-31269	<u>Elevations</u> Ground ~669 ft Water Table ~404 ft(1973) <u>Site Depth</u> NA
<u>Source and Description of Waste</u> Regulated equipment storage.		
<u>Description of Facility</u> (See 218-E-2 for acreage) Above ground storage.		
<u>Radionuclide Content</u> (calculated from discharge data) NA		
<u>NOTE:</u> Burial Ground 218-E-9 appears never to have been a burial ground; but to have been used exclusively as an "Above Ground Storage Site". The 218-E-9 listed coordinates of N-44395, W-53426; N-44827, W-53426; N-44827, W-53516; and N-44395, W-53516 fall within the boundaries of the east 90 feet of the 218-E-2 Burial Ground. It is recommended that the designation 218-E-9 be deleted from the burial ground records. <u>NOTE:</u> Extensive work was done in FY1979 to upgrade 218-E-2 and 218-E-9 Burial Grounds. See 218-E-2 writeup for details.		



Reference: II-2-2479

FIGURE A.2: BURIAL GROUNDS 218-E-2, 2A, 5, 5A, AND 9

CONTAMINATED SOLIDS STORAGE AND BURIAL SITES

RHO-CD-673

I. NW

<u>Name/Type of Facility</u>	<u>Last Designation</u>	<u>Number</u>
Burial ground.	200 East/Industrial Waste No. 10	218-E-10
<u>Location</u> 200 East, N.W. Quadrant	<u>Service Dates</u>	<u>Status</u>
About 2000 ft north and west of B Plant. Directly west of 218-E-5A.	February 1960	Active
<u>Site Coordinates</u>	<u>Reference Drawings</u>	<u>Elevations</u>
N-44395, W-55444 N-44464, W-55440	H-2-31269 H-2-55534	Ground 671 ft Water Table 404 ft(1973) Site Depth 15-25 ft
<u>Source and Description of Waste</u>		
Failed equipment and industrial waste (approximately 5.4×10^6 ft ³).		
<u>Description of Facility</u>		
8 trenches running north and south, approx. 400 ft long, surface area: 7.83×10^5 ft ² . Trench #1 is 24' deep, 15 ft wide in the bottom, and 63 ft wide at ground level. All other trenches are 15 ft deep, 16 ft wide in the bottom, and 61 ft wide at ground level.		
<u>Radionuclide Content</u> (calculated from discharge data)		
<u>Radionuclide</u>	<u>At Time of Burial</u>	<u>As of 9/30/78</u>
U, g	8.0×10^5	8.0×10^5
Pu, g	4.9×10^3	4.9×10^3
Total Beta, Ci	2.4×10^5	4.33×10^5
⁹⁰ Sr, Ci	4.8×10^3	1.02×10^5
¹⁰⁶ Ru, Ci	1.0×10^4	544.0
¹³⁷ Cs, Ci	5.1×10^3	1.23×10^5
Misc. Radionuclides	1.12×10^3	

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-67J

I. NW

<u>Name/Type of Facility</u> Unplanned Release	<u>Fast Designation</u> 241-8-152	<u>Number</u> UN-216-E-2
<u>Location</u> 200 East, N.W. Quadrant 241-8-152 Diversion Box Southwest corner of 241-8 Tank Farm	<u>Service Dates</u> Spring 1954	<u>Status</u> Inactive
<u>Site Coordinates</u> (Approximate) N-45000, W-53000	<u>Reference Drawings</u> H-2-4450 Sheet 7	<u>Elevations</u> Ground 625 ft Water Table 392 ft (1973) Site Depth Several trenches

Source and Description of Waste

Description of Facility

An area of approximately 50 ft² next to the 241-8-152 Diversion Box was contaminated during work on the diversion box. A portion of the contaminated soil was removed and the remainder covered with several inches of clean soil..

Radionuclide Content (at time of discharge)

Approximately 1 Ci Mixed Fission Products.

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. NW

<u>Name/Type of Facility</u> Unplanned Release		<u>Fast Designation</u> 241-8X-155 Diversion Box ground contamination	<u>Number</u> UN-216-E-6
<u>Location</u> 200 East, N.W. Quadrant 241-8X-155 Diversion Box approximately 900 feet south of the 241-8X Tank Farm.		<u>Service Dates</u> October 1955	<u>Status</u>
<u>Site Coordinates (Approximate)</u> H-44200, W-53200	<u>Reference Drawings</u> H-2-44500 Sheet 7	<u>Elevations</u> Ground 625 ft Water Table 329 ft(1973) <u>Site Depth</u> Near surface	

Source and Description of Waste

Mixed fission product salt waste from B-Plant.

Description of Facility

Ground contamination near 241-8X-155 Diversion box resulting from pressure testing of lines and jumpers in the 155-8X Diversion Box. Approximately 200 ft² of surface area was covered with clean soil.

Radionuclide Content (at time of discharge)

Approximately 10 Ci Fission Product.

History:

A spill that occurred during pressure testing of lines and jumpers in the 155-8X Diversion Box caused ground contamination to a maximum dose rate of 22.6 rads/hr at surface. Effected area is approximately ~~200 feet~~ ^{200 ft²} square. It has been covered with clean soil.

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. NW

<u>Name/Type of Facility</u> Unplanned Release	<u>Fast Designation</u> 221-8, R-3 line break	<u>Number</u> UN-216-E-8
<u>Location</u> 200 East, N.W. Quadrant South of 221-8, between the building and 7th Street.	<u>Service Dates</u> 1946	<u>Status</u> --
<u>Site Coordinates (Approximate)</u> N-42575, W-53450	<u>Reference Drawings</u> H-2-44500 Sheet 7	<u>Elevations</u> Ground 686 ft Water Table 404 ft(1973) Site Depth NA
<u>Source and Description of Waste</u> Metal waste from 221-8.		
<u>Description of Facility</u> An area approximately 100 ft x 500 ft long due to waste from a leak in the R-3 line. During subsequent construction activity the major portion of the contaminated soil was removed to the 200-E Dry Waste Burial Ground.		
<u>Radionuclide Content (at time of discharge)</u> <5Ci mixed fission products remain.		

Ref. 5.103

CONTAMINATED LIQUID DISPOSAL SITES

RHO-CD-673

I. NW

<u>Name/Type of Facility</u>		<u>Fast Designation</u>	<u>Number</u>
Unplanned Release		221-8, R-13 Line Break Near Utility Pit	UN-216-E-13
<u>Location</u>		<u>Service Dates</u>	<u>Status</u>
200 East, N.W. Quadrant 221-8, R-13 Utility Pit		7/20/72	--
<u>Site Coordinates (Approximate)</u>	<u>Reference Drawings</u>	<u>Elevations</u>	
N-42500, W-53850	H-2-4450 Sheet 7	Ground	700 ft
		Water Table	402 ft(1973)
		Site Depth	NA
<u>Source and Description of Waste</u>			
221-8 Process Waste.			
<u>Description of Facility</u>			
Leak in pipeline from Tank 18-1, 221-8 Bldg. to 154-BX Diversion Box near the R-13 Utility Pit. Radiation measurements in the pit were 15 rad/hr at 2 in.			
<u>Radionuclide Content (at time of discharge)</u>			
<u>Radionuclide</u>	<u>At Time of Discharge</u>	<u>As of 12/31/73</u>	
¹³⁷ Cs, C1	~15	~14	
<u>History:</u>			
Excavation of an unencased line (from tank 18-1, 221-8 Building to 154-BX Diversion Box) near the utility pit at R-13 disclosed a process waste leak. Radiation measurements taken at bottom of the pit read 15 rads/hr within two inches of the source.			
(See Attachment)			
Ref. 5.104			

913218.0023

PROCESSING DIVISION
RADIATION OCCURRENCE

M. D. Alford	RADIATION OCCURRENCE FACTS	
	DATE	TIME
	7/20/72	0830
LOCATION		
221-B, R-13 Pit		
RADIATION OCCURRENCE TYPE: <u>3-8</u> Loss of control of contamination from a radiation zone.	CAUSE CODE: <u>1-8</u> Failure of equipment (line or flange leak).	

COMPLETE DESCRIPTION AND CAUSE

During a routine survey, high radiation was discovered in the R-13 pit adjacent to the 221-B Canyon Building. Radiation levels of 15 rads/hr existed in the northeast corner of the pit near the bottom (approximately six feet down). It is suspected the contamination had seeped into the pit from the east side where several unencased lines leave the building. The line most likely to have caused the contamination is the 18-1 waste line that goes to the 154 BX diversion box just south of the 221-B Building.

CC: GE Backman (2) BJ McMurray (2) GC Oberg FA Perkins RE Smith	ACTION TAKEN The area was zoned off and excavation started to try and locate the leak.
INVESTIGATED BY O. L. Mahan/F. A. Perkins	
DATE OF INVESTIGATION 7/20/72	

EXPOSED EMPLOYEES

None

120-9125-16

Date August 18, 1987

To File

From B. W. Mercer

Subject Solid Waste Volume Estimates for Selected 200 Area
Burial Grounds

Supervisory personnel in process operation and radiation monitoring in 200-West Area during the period 1944 to 1968 were interviewed to obtain estimates of the volumes of solid waste disposed to several burial grounds in the 200-West Area. The estimates are as follows:

218-W-1	-	250,000 ft ³
218-W-2	-	290,000 ft ³
218-W-3	-	390,000 ft ³
218-W-4A	-	630,000 ft ³
218-W-1A	-	480,000 ft ³

BWM:DAL:dar

REFERENCE 7

Hanford Wells, PNL-5397, February 1985

RHO FILE 1									
WELL DESIGNATION	COORDINATES	CASING ELEV. (FT-MSL)	INIT. DRILL DEPTH (FT) WATER	TO DIA. (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
EMA NO.									
299 W 6 1	N 846898								
2998 2927R	P W 874396	702.53	476 243	8.0	318	238-288	8-57		
299 W 7 51	N 845525								
	P W 876788		25	6.0			7-84		DESTROYED
299 W 7 52	N 845538								
	P W 876825		25	6.0			7-84		DESTROYED
299 W 7 53	N 845475								
	P W 876865		25	6.0			7-84		DESTROYED
299 W18 1	N 843558								
2892R	P W 876218	674.86	385 287	8.0	385	198-278	8-47	224-T-4	
299 W18 2	N 843154								
2893R	P W 876183	674.33	238 288	4.0	228	281-229	12-51	224-T-18	
299 W18 3	N 843348								
2885R	P W 875988	672.66	239 286	8.0	228	194-238	11-51	241-T-15 221-T-15	6 IN. SCREEN 181-234
299 W18 4	N 843833								
2886R	P W 875977	678.95	245 284	8.0	236	198-245	11-52	241-T-16	
299 W18 5	N 842669								
2898	P W 876489	672.31	248 284	8.0	248	175-228	4-54	241-T-28	
299 W18 6	N 842678								
	P W 876895		228	6.0			8-8		
299 W18 7	N 842678								
	P W 875615		228	6.0			8-8		
58- 8- 1	N 843799								
299 W18 8	P W 875688	688.33	252 214	6.0		205-251	6-73	2997	SCREEN
2997 2996R									

RHO FILE

WELL DESIGNATION		COORDINATES	CASING ELEV. (FT-MSL)	INIT. DRILL DEPTH (FT) TO		DIA. (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
EHA NO.				DEPTH (FT)	WATER						
299 W19 2	P	N 836849	694.84	388	232	0.0	240	235-295	8-57		
2928R	W	873888									
299 W19 3	P	N 837819	695.12	381	225	0.0	244	238-288	9-57		
2991 2929R	W	874898									
299 W19 4	P	N 839888	715.26	558	255	0.0	358	255-535	2-68		
2938R	W	871999									
	O		715.52	288	253	1.50		268-288	5-65		
	P		715.52	535	256	1.50	464	518-535	6-64		
	Q		715.52	481	256	1.50	488	456-481	6-64		
	R		715.52	411	256	1.50	348	386-411	6-64		
	S			378	256			345-378	8-8		
299 W19 5	P	N 836858	788.88	235	215	6.0	238	285-238	11-68		
2968R	W	874685									
299 W19 6	P	N 836858	788.88	422	216	6.0	418	388-411	12-68		
2969R	W	874718									
299 W19 7	P	N 837888	788.88	235	217	6.0	223	288-233	11-68		
2978R	W	874125									
299 W19 8	P	N 838574		585	248	0.0		NONE	6-71		
	W	873268									
299 W19 18			788.88	573		3.5	468	NONE	4-76	DH-7	
299 W19 11	P	N 837868		258		6.0			4-83		6" SCREEN 228-258 GROUTED
2619R	W	874218									

144

9413218.0430

WELL DESIGNATION ----- EHA NO.	COORDINATES	CASING ELEV. (FT-MSL)	INIT. DRILL DEPTH (FT) TO DIA. (FT) WATER (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
499 SI 8P	S 881312 P W 887521	492.58	149			8-71	DN-13	
499 SI 8G	S 881888 P W 887881	548.88	77			8-71	DN-14	
499 SI 8H	S 888692 P W 887888	646.58	1964 159 18.8	1835		8-77	PFTP WELL 83	
→ 499 S8 4817	S 888188 P W 887478	548.59	399 162 8.8	399	221-396	3-72	PFTP WELL 2	WATER SUPPLY WELL
→ 499 S8 4818	S 888188 P W 887978	546.98	294 158 8.8	294	188-281	3-72	PFTP WELL 1	WATER SUPPLY WELL

173

Ref 7.3

9413218.0431

WELL DESIGNATION	COORDINATES	CASING ELEV. (FT-MSL)	INIT. DRILL DEPTH (FT) WATER	DEPTH TO DIA. (IN)	DEPTH TO BOTTOM (FT)	MIN-1" PERFORATED DEPTH (FT)	TE CONP. (M-Y)	FORMER DESIGNATION	COMMENTS
699 24 33 4416 4890R	N 023809 P W 033315	524.21	165 124	8.0	159	116-164	8-48	25-35	CEMENT PLUG AT 159FT SAMPLE PUMP
699 24 46 4525	N 023968 P W 045994	591.46	600 109	10.0	600	180-670	10-50		SAMPLE PUMP PLUG AT 230
699 24 95							6-0	24-133	PROJECT ALE WATER SUPPLY WELL
699 25 E2	N 024700 P E 001600	404.70	135				0-74	1C-6P-25	
699 25 20	N 024586 P W 019731	521.90	992 110	6.0	158		0-01	8-22	
699 25 26	N 024809 P W 025794	515.50	605 DRY	6.0	52		0-01	8-0	
699 25 31	N 025202 P W 050985	511.76	016 110	6.0	600		1-01	8-6	
699 25 55 4415	N 025357 P W 055192	676.55	315 266	8.0	309	260-314	7-40	25-56 USGS-1	CEMENT PLUG AT 309FT SAMPLE PUMP
699 25 70 4452	N 025250 P W 070000	629.56	460 179	8.0	220	175-440	0-40		CEMENT PLUG AT 220FT SAMPLE PUMP
	O	629.02	200 179	1.50		100-200	1-65		REMOVED
	P	629.02	430 179	1.50	437	420-430	5-64		REMOVED
	Q	629.02	390 179	1.50	390	380-390	5-64		REMOVED
	R	629.02	390 179	1.50		320-330	5-64		REMOVED
	S	629.02	272 179	1.50	272	262-272	5-64		REMOVED
699 25 00 4440	N 025000 P W 079512	614.63	336 174	4.0	1210	170-265	11-40	DB-14	DEEPEMED 1-79, NX CASING TO 049FT

220

Ref 7.4

WELL DESIGNATION EMA NO.	COORDINATES	CASING ELEV. (FT-MSL)	INIT. DEPTH DEPTH (FT) TO DIA. (FT) WATER (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
699 31 65 4495	N 030536 P W 065357	683.09	450 242 8.0	318	240-450	8-57	699-30-65	
	O	683.35	260 242 1.50	260	240-260	4-65		
	P	683.35	430 243 1.50	353	410-430	6-64		
	Q	683.35	390 242 1.50	371	370-390	6-64		
	R	683.35	330 242 1.50	322	310-330	6-64		
699 31 84A	N 031316 P W 083729	625.05	4398 6.0			6-83	DC-16A	
699 31 84B		625.12	1600			12-82	DC-16B	
699 31 84C	N 031290 P W 084230	625.00	3854			10-82	DC-16C	
699 32 18	N 032062 P W 017582	452.64	56 6.0	60		8-80	GOLDER 86	
699 32 22 4794	N 032003 P W 021995	517.55	171 119 6.0	168	111-169	2-71		SAMPLE PUMP
699 32 26	N 031647 P W 026279	520.59	715 6.0			8-80	GOLDER 48	
699 32 31	N 031873 P W 031489	522.00	118 6.0	162		8-80	GOLDER 71A	
699 32 32	N 031860 P W 031504	520.53	780 117 6.0	147		8-80	GOLDER 71	
699 32 42 4777	N 032470 P W 042450	517.42	125 116 6.0	122	110-120	8-68		PLUG AT 122

WELL DESIGNATION	COORDINATES	CASING ELEV. (FT-MSL)	INIT. DRILL DEPTH (FT) WATER	TO DIA. (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
EMA NO.									
699 34 89A		643.00	441	8.0		233-353	6-81	RRL-6A	
699 34 89B	N 033507 P W 008016	643.44	4040	3.0			9-81	RRL-6B	
699 35 3	N 035004 P W 003062	486.36	480	6.0			0-80	GOLDER 53	DESTROYED
699 35 9 4419	N 034700 P W 009175	499.03	176 117	8.0	172	110-135	10-50	USGS NO.10 34.7-9.2	SAMPLE PUMP
699 35 16	N 034831 P W 015715	457.03	565 61	6.0	100		8-0	GOLDER 29	
699 35 19A	N 034728 P W 019074	473.92	556	6.0			0-79	GOLDER 0	
699 35 19B	N 034671 P W 019026	482.00	82	6.0	106		0-79	GOLDER 8A	
699 35 27	N 034673 P W 027437	531.07	1403 159	2.0		NONE	12-73	DB-4	
699 35 28	N 034519 P W 028253	534.36	685 132	6.0	141		0-80	GOLDER 74	
699 35 66 4494	N 034860 P W 065750	725.65	450 280	8.0	307	280-317	6-57		CEMENT PLUG AT 322FT SAMPLE PUMP
699 35 70 4441	N 034523 P W 069980	693.72	325 240	8.0	266	235-320	9-40	34.5-69.5	6" LIN 0-233 SCREEN 233-53, SAMPLE PUMP
699 35 78A 4445 4869H	N 035470 P W 078190	660.65	279 184	0.0	232	180-279	0-50	35.5-70 35-79	CEMENT PLUG AT 232FT SAMPLE PUMP

WELL DESIGNATION	COORDINATES	CASING ELEV. (FT-MSL)	INIT. DEPTH DEPTH (FT) TO DIA. (FT) WATER (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
EMA NO.								
699 37 22	N 037437 P W 022064	478.21	117	6.0		0-80	GOLDER 83	
699 37 25	N 037305 P W 024051	501.37	135	6.0		0-80	GOLDER 76	
699 37 36	N 036038 P W 035037	543.97	430	6.0	44	0-80	GOLDER 47	
699 37 43 4400	N 037063 P W 042074	690.17	517 207	8.0	305	316-334	11-55 38-43 37-42	PLUGGED AT 338FT SAMPLE PUMP
	O	690.43	340 207	1.50	340	320-340	12-64	REMOVED
4740	P	690.43	499 204	1.50	500	400-490	5-64	REMOVED
4749	Q	690.43	440 204	1.50	440	420-430	5-64	REMOVED
	H	690.43	390 204	1.50	303	370-380	5-64	REMOVED
699 37 02A 4554	N 037010 P W 001900	636.75	440 163	8.0	175	155-410	10-60	CEMENT PLUG AT 175FT SAMPLE PUMP GROUTED
	O	636.90	200 163	1.50	104	190-200	4-64	REMOVED
4621	P	636.95	400 163	1.50	349	400-400	2-62	REMOVED
4622	Q	636.95	300 162	1.50	362	340-380	2-62	REMOVED
4623	R	636.95	320 162	1.50	311	290-320	2-62	REMOVED
4624	S	636.95	251 159	1.50	242	221-251	2-62	REMOVED
699 37 02B 4555	N 037000 P W 001999	636.07	627 162	8.0	200	163-590	10-60	
	O	636.30	105 162	1.50	296	165-105	10-64	
4605	P	636.32	560	1.50	344	540-560	5-64	
4606	Q	636.30	410	1.50	104	390-410	5-64	
4607	R	636.30	330	1.50	141	310-330	5-64	
4608	S	636.30	250	1.50	414	230-250	5-64	
4608	S	636.30	250	1.50	414	230-250	5-64	
	T	636.32	370	1.50	312	350-370	5-64	REMOVED

WELL DESIGNATION			COORDINATES	CASING ELEV. (FT-MSL)	INIT. DEPTH (FT) TO DIA. (IN)			DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
EMA NO.												
699	41	5	P N 040628 W 004942	483.88	273	118	6.0	263		8-88	GOLDER 118	
699	41	10	P N 041403 W 009614	502.83	293		6.0			8-79	GOLDER 5	
699	41	11	P N 041053 W 010640	512.70	430		6.0			8-88	GOLDER 104	
699	41	20	P N 041407 W 019741	485.87	497		6.0			8-88	GOLDER 31	
699 4430	41	23	P N 040692 W 022076	466.58	120	71	8.0	89	65 -115	7-48	48-24	SAMPLE PUMP
699	41	25	P N 040642 W 025081	468.87	105	72	6.0	81		8-88	GOLDER 82	
699	41	31	P N 041020 W 030731	504.63	335	106	6.0	126		8-88	GOLDER 44	
699	41	91	P N 041473 W 091220	652.64	4000		3.9			10-82	RRL-14	4.5 IN. CASING TO 2070
699 4859	42	2	P N 042075 W 001920	433.50	95	76	6.0		74 - 90	8-79		SAMPLE PUMP
699	42	3	P N 041990 W 003225	444.27	420		6.0			8-88	GOLDER 116	
699	42	10	P N 041047 W 009652	495.50	220	130	6.0	222		8-88	GOLDER 112	
699 4517	42	12A	P N 042474 W 011725	514.27	350	141	8.0	180	120-320	12-57	43-11 42-12	PLUG 100, SAMPLE PUMP 6" LINER 101-103

238

Ref 7.7

WELL DESIGNATION ----- EMA NO.	COORDINATES	CASING ELEV. (FT-MSL)	INIT. DRILL DEPTH (FT) WATER	TO DIA. (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
699 47 92	N 047410 P W 091631	887.58	755	6.8	743		10-81	BRL-8	
699 47 88A	N 046785 P W 079816	710.61		6.8			11-83	DC-28A	
	1		269	1.75		658-672	12-83		SCREEN
	2		259	1.75		583-513	2-84		SCREEN
699 47 88B	N 046910 P W 079835	712.34	312	12.5	1632		9-83	DC-28B	
699 47 88C	N 046786 P W 079919	711.22		12.5			11-83	DC-28C	
	1	712.58	318	1.75		3567-3589	1-84		SCREEN
	2	712.66	318	1.75		2932-2954	1-84		SCREEN
	3	712.84	311	1.75		2757-2779	2-84		SCREEN
	4	713.82	312	1.75		2417-2439	2-84		SCREEN
	5	713.18	312	1.75		1878-1892	2-84		SCREEN
	6	713.34	312	1.75		1619-1629	2-84		SCREEN
699 47 88D	N 046986 P W 088038		1485	388	12.5		1-84	DC-28D	
	1	713.14	299	1.75		1386-1488	1-84		SCREEN
699 48 7 4756	N 048478 P W 086547	384.72	54	29	12.8	49	12 - 32	8-43	HD-6W HAN-6
699 48 17	N 048478 P W 016616	429.58	83		6.8		4-44	HD-22TH HAN-25	FILLED IN
699 48 18 4850	N 047983 P W 017878	424.98	86	63	6.8	85	68 - 75	3-44	HD-21TH HAN-24

DESIGNATION EHA NO.	COORDINATES	CASING ELEV. (FT-MSL)	DRILL DEPTH (FT) WATER	TO DIA. (IN)	DE B. OM (FT)	PERFORATED DEPTH (FT)	COMP. (N-Y)	FORMER DESIGNATION	COMMENTS
699 50 10	P N 049944 W 010170	389.78	46	48.0			8-8	ND-5W REP 2 839 HAN-5	FILLED IN
699 50 14	P N 049888 W 013917	392.43	33	12.0			6-43	HANFORD CITY WELL HAN-28	FILLED IN
699 50 20A 4160	P N 050000 W 020350	529.00	260	6.0	260		4-45	BY TELE. EX WELL	PUMPED WELL FILLED IN
699 50 20B 4844	P N 050203 W 027510	537.30	167 145	6.0	161	146-156	8-71	GM-5	SCREEN 146-156 FT. SAMPLE PUMP
699 50 28C	P N 050076 W 028219	534.77	390 DRY	6.0			8-80	GOLDER 20	
699 50 30 4451	P N 050299 W 029833	528.04	380 136	8.0	170	130-221	7-48		PLUG AT 170
699 50 42 4460	P N 050206 W 041909	466.84	125 59	8.0	100	53 - 64	5-55		SAMPLE PUMP PLUG AT 100
	O	467.10	90 59	1.50	90	70 - 90	4-65		REMOVED
4666	P	466.84	115 59	1.50	115	110-115	6-77		60 SLOT SCREEN
699 50 45	P N 050150 W 044992	451.41	170	6.0		133-170	5-80		10 SLOT SCREEN
699 50 48 4883	P N 049980 W 047580	550.39	250	6.0		213-250	8-80		20 SLOT SCREEN
699 50 53 4473	P N 049840 W 053267	556.30	105 156	8.0	159	142-159	2-55	50-54	SAMPLE PUMP PLUG AT 159
699 50 85 4497	P N 049873 W 004505	739.35	600 204	8.0	335	205-545	11-57	699-50-84	CEMENT PLUG AT 335FT SAMPLE PUMP
	O	739.60	300 205	1.50	301	200-300	4-65		REMOVED
	P	739.35	525 292	1.50	525	520-525	8-78		60 SLOT SCREEN
	Q	739.60	540 290	1.50	300	520-540	5-64		REMOVED
	R	739.60	480 205	1.50	369	460-480	5-64		REMOVED
	S	739.60	420	1.50	10	400-420	5-64		REMOVED

252

Ref 7.9

WELL DESIGNATION EMA NO.	COORDINATES	CASING ELEV. (FT-MSL)	INIT. DRILL DEPTH (FT) WATER	DEPTH TO DIA. (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
699 55 60B 4835	N 055425 P W 060140	573.68	288 173	24.8	288	238-285	7-44	200ND-5W	14.28.24. IN-CASINGS
699 55 60C		571.92					8-8		
699 55 63	N 055100 P W 062740	572.00	190 39	14.0	190		5-44	200ND-4W	CASING REMOVED
699 55 65A	N 055100 P W 065380	580.00	136	16.0	136		2-44	200ND-2W	CASING REMOVED
699 55 65B	N 055300 P W 065380	580.00	146 43	16.0	146		4-44	200ND-3W	CASING REMOVED
699 55 65C	N 055100 P W 065300	580.00	146		146		8-44	200ND-6W	CASING REMOVED
699 55 70 4442	N 055326 P W 069955	569.03	205 140	8.0	188	136-202	6-48		CEMENT PLUG 188FT
	O	569.38	160 140	1.50	160	150-160	5-65		REMOVED
4625	P	569.03	195 140	1.50	195	190-195	6-77		60 SLOT SCREEN
699 55 76 4533	N 055001 P W 075897	583.24	230 142	8.0	192	141-221	1-59		CEMENT PLUG AT 192FT SAMPLE PUMP
	O	583.50	170 142	1.50		150-170	5-65		REMOVED
4671	P	583.50	203 142	1.50	201	183-203	9-63		REMOVED
699 55 89 4453	N 054969 P W 080592	617.43	235 167	8.0	215	160-170	11-48	55-88.5	CEMENT PLUG AT 215FT SAMPLE PUMP
	O	617.69	190 165	1.50	191	160-190	4-63		REMOVED
4665	P	617.69	220 165	1.50	220	200-220	9-63		REMOVED

259

Ref 7.11

REFERENCE 8

Ground Water Monitoring at Hanford Site,

January-December 1984, PNL-5408

621012016
943218.0729

File Note

Date: 10/29/87

From: RD Stenner

Subject: Prefix number change for FFTF well identification numbers as used in References 7 and 8 of U.S. DOE Hanford 200 Area NPL package

The document in Reference 8 uses the 699 prefix for the FFTF wells which is the general prefix used to indicate general Hanford Site with no attachment to a specifically defined Hanford Area. The document in Reference 7 uses the 499 prefix for the FFTF wells which is the prefix for indicating an assignment specifically to the defined Hanford 400 Area. The wells S0-7 and S0-8 with the 699 prefix in Reference 8 and the S0-7 and S0-8 wells with the 499 prefix in Reference 7 are the same wells.

94720.000
0107246

RADIOLOGICAL IMPACT

Ground-water transport of radionuclides at the Hanford Site represents a potential pathway for exposure to radiation via water obtained from wells that tap the unconfined aquifer or from the Columbia River into which the unconfined aquifer discharges. The following discussion examines these potential pathways.

UNCONFINED AQUIFER

During 1984, drinking water for the FFTF (wells 699-S0-7 and 699-S0-8), the Yakima Barricade Guardhouse (well 699-49-100C), the Arid Land Ecology (ALE) site (spring and well 699-S18-51), and the Hanford Patrol Firing Range (well 699-S28-E0) was obtained from the unconfined aquifer, or in the case of the spring the confined aquifer. Figures 1 and 4 show the location of these drinking water sources. Untreated water samples were collected quarterly from taps at the various sites. Analyses were conducted to determine the concentrations of gross alpha, ^{60}Co , ^{137}Cs , ^{90}Sr , ^3H and gross beta at all the sites, and additionally, ^{106}Ru and ^{22}Na at the FFTF. Calculations were performed by computer model (Napier, Kennedy and Soldat 1980) to determine if the annual dose exceeded the 4 mrem dose equivalent limit established by EPA (U.S. Environmental Protection Agency 1984) and the State of Washington (Washington State Department of Social and Health Services 1978) for drinking water.

Quarterly drinking water samples collected at the Patrol Firing Range, ALE, and the Yakima Barricade were at or below the detection limits for the various constituents listed above. At the FFTF, only tritium appeared at levels well above detection, or State of Washington or Federal EPA screening levels. Tritium concentrations ranged from 24,000 to 35,000 pCi/l, with a mean of 29,000 pCi/l. The annual intake of 250 l of water (based on an occupational consumption of one l/d for 250 d/yr) from this source, at the mean concentration of 29,000 pCi/l, would produce a 50-year committed whole body dose equivalent of 0.46 mrem. This calculated dose equivalent is less than 15% of the Washington State Drinking Water Standard of 4 mrem per year.

Additional monitoring of all DOE drinking water systems at Hanford is conducted by the HEHF. Information on this effort can be obtained from Maas (1985).

COLUMBIA RIVER

Ground water from the unconfined aquifer enters the Columbia River via subsurface flow and springs that emanate from the riverbank, as reported by McCormack and Carlile (1984). The amount of tritium entering the river is calculated, based on the average concentrations of tritium in wells near the river and the flow rate of ground water into the river.

During 1984, tritium concentrations measured in wells at the old Hanford Townsite were in the range of approximately 100,000 to 250,000 pCi/l. The average concentration of tritium entering the river in this area during 1984 was estimated to be 172,000 pCi/l. Except for some small zones around the 100-B, C, 100-K, and 100-N Areas (see Appendix B.2 and Figure 5), ground water from the Hanford Townsite area represents the highest probable tritium concentrations entering the Columbia River.

Despite the fact that tritium enters the Columbia River near the Hanford Townsite, the impact to the river is low. The average annual flow rate from the unconfined aquifer into this section of the river near the Hanford Townsite has been estimated to be approximately 0.085 m³/sec (3 cfs). This is based on the ground-water Variable Thickness Transient (VTT) model developed for the Hanford Site (Reisenauer 1979). During 1984, the average Columbia River flow rate at Priest Rapids Dam was approximately 3,186 m³/sec (112,500 cfs) (Price et al. 1985). Ground water entering the Columbia River from the Hanford Site was, therefore, diluted by several orders of magnitude because of the difference between the river and ground-water flow rates. The tritium concentration in the river because of ground water in this area was calculated to be nearly 5 pCi/l. During 1984, the average background tritium concentration in the Columbia River upstream from the site was 130 ± 15 pCi/l, and the average concentration downstream from the site was 170 ± 23 pCi/l (Price et al. 1985). The contribution by ground water compared to background concentrations was not significant.

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REPORT

05 MAR 84 to 19 NOV 84

WATER

SANITARY WATER

SAN GRAB

UNFILTERED

Samp #: 1220

FFTF 481 BLDG

108/H 3 LIQ

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
05 MAR 84	05 MAR 84	3.54E+04 +/- 5.93E+02	
01 JUN 84	01 JUN 84	2.64E+04 +/- 5.11E+02	
20 AUG 84	20 AUG 84	2.96E+04 +/- 5.41E+02	
19 NOV 84	19 NOV 84	2.38E+04 +/- 4.84E+02	

Fraction of Results > DL: 4/ 4 Mean: 2.88E+04
Minimum: 2.38E+04 (19 NOV 84) Standard Error of Mean: 5.64E+03
Maximum: 3.54E+04 (05 MAR 84) Standard Deviation: 1.13E+04
Median: 2.64E+04

REFERENCE 9

**Project Inspection, Log Book Project V-749,
400 Area Water Systems Improvements Water Well (FFTF Well) No. 4**

FILE NOTE

Date: 12/28/87

By: R.D. Stenner *R.D. Stenner*

Re: Discussion regarding the need for drilling the new deeper drinking water well at FFTF

The new drinking water well (well 499-S1-8C) was drilled to provide a deeper source of drinking water at the FFTF in order to provide drinking water that met the drinking water standards for tritium. The water from this new well is used exclusively except during high water demand periods and during preventative maintenance scheduled outages where the water from the other two wells is mixed in the system to supply the needs of the FFTF. The general percentage of water mix in CY-1986 is as follows: 83.1% from 499-S1-8C, 16.8% from 499-S0-7, and 0.1% from 499-S0-8.

943200

Persons invited to attend:

<u>Meier Associates</u>	<u>Onwigo Drilling</u>	<u>J. A. J.</u>
James Canon	Jerry Bultina	Bill Swift
Terry Meier	Dale Bingham	
Randell Brown		

W. H. C.

Ken Blair
John Forsberg

(48° and clear)

2/28/85

Drilling of the well was completed on February 27, 1985 to a depth of 400 feet. The casing has been installed to a depth of 360 feet, leaving 40 feet of open hole.

A meeting was held with the contractor, J. A. J., W. H. C., D. O. E. and Meier Associates. In attendance were:

<u>Onwigo Drilling</u>	<u>J. A. J.</u>	<u>W. H. C.</u>
Dale Bingham	Bill Swift	John Forsberg
Jerry Bultina		

<u>D. O. E.</u>	<u>Meier Associates</u>
John Neath	James Canon
	Randell Brown

The discussion was on well screening and development. The driller suggested driving casing to the 400 foot depth, and perforating until the desired rate is available, which would also bring an anticipated savings, as perforating would be less expensive than screening.

Meier Associates suggested screening the lower portion of the hole for maximum yield at that depth, as the hole is now open. It was agreed that the driller would install 10 feet of solid casing in the bottom of the hole, 30 feet of screen from depth 390 feet to 360 feet, then test pump the well to find what the G. P. M. would be. If the G. P. M. is not sufficient (200 G. P. M. minimum) perforations will be made at depths determined by the driller and the engineer.

If additional savings are obtained, this money will be spent in the testing and developing of the well.

The driller will discuss the soil analysis and screen design with Mr. Brown, and allowed to order screen as verbally approved by Mr. Brown. No work will be allowed to proceed without the submittal from the contractor on the analysis, screen design, alternatives for developing the well (such as perforating) and testing.

REFERENCE 10

Washington State Public Supply System Listing

43209

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, REGION 8
1200 SIXTH AVENUE
SEATTLE, WA 98101

Ref

FACSIMILE REQUEST AND COVER SHEET

PLEASE PRINT IN BLACK INK ONLY

TO

Bob Stenner

Office/Phone

Battelle

Region/Lab

FROM

David Bennett

Phone

399-2103

Office

Superfund

Date

8/6/87

Number of Pages to include this cover sheet

5

Please number all pages

INFORMATION FOR SENDING FACSIMILE MESSAGES

Equipment

Facsimile
number

509-376-
4609

Verification
number

509-376-
8753

Rapicom 3300

FTS 399-4872 (auto)
Comm:206/442-4872

FTS 399-4141
Comm:206/442-4141

only info for
Townships + Rangers given
therefore none in others

PAGE 1 OF 5 PAGES

PAGE 15
06/12/87

३३

10W/31E-32001001			275.00 U	BRIAN	STARKS	TREE FARM ROAD	KENNEWICK WA. 99336
10W/31E-32L02	4.00		350.00 N	TERRY	SMITH	3029 WEST 2ND AVE.	KENNEWICK WA. 99336
10W/31E-32L03	4.70	502	290.00 U	HENRY	FORD	90 TREE FARM ROAD	PASCO WA. 99301
10W/31E-32M01	9.80	889	165.00 N	MIKE	TOWIN	431 MEERER ROAD	PASCO WA. 99301
10W/31E-32M02	1.50	459	400.00 N	JOHN	HAUGEN	281 TREE FARM ROAD	PASCO WA. 99301
10W/31E-32M03	13.00	934	295.00 U	ED	SMITH	30 LAURIE LANE	PASCO WA. 99301
11N/28E-13E01	7.10		140.00 N	ROBERT	HIGGEE	3550 WEST FIR ROAD	PASCO WA. 99301 WITHIN 3 MI OF ZOO AREA BOUNDARY
11N/28E-36R01	0.10		746.00 N	BOB	BROWN	ROUTE 1 BOX 97	PASCO WA. 99301 WITHIN 3 MI OF ZOO AREA BOUNDARY
11N/29E-01A01	7.90	492	40.00 N	ALVIN	TAYLOR	14020 GLADE NORTH	ELTOPIA WA. 99330
11N/29E-07M01	0.09	478	590.00 N	STORAGE CO.	PRICE COLD	45 FIR WAY	ELTOPIA WA. 99330 WITHIN 3 MI OF ZOO AREA BOUNDARY
11N/29E-12E01	4.60	778	105.00 N	ROBERT	WOOD	FINCREST ROAD	ELTOPIA WA. 99330
11N/29E-13C01	1.30	852	30.00 N	ROBERT	DARRINGTON	FIR ROAD	ELTOPIA WA. 99330
11N/29E-28R01	14.00	853	87.00 U	KEN	MCCALL	BLOCK 16 UNIT 144	MATHEWS CORNER WA. 99330
11N/29E-34D02	1.10		78.00	C	SAYRE	CHERRY DRIVE	MATHEWS CORNER WA. 99330
11N/29E-34J01	0.10	597	106.00 N		BENSON & RANSON	1935 EAST SAGEMOOR ROAD	ELTOPIA WA. 99330
11N/29E-34J01	0.10	597	106.00 N		BENSON & RANSON	1935 EAST SAGEMOOR ROAD	ELTOPIA WA. 99330
11N/29E-34K01	6.70	608	160.00 N	JACK	BOYD	ROUTE 1 BOX 982A	PASCO WA. 99301
11N/30E-02R01	4.70	609	124.00 I	ALLEN	HAILEY	993 BLANTON ROAD	ELTOPIA WA. 99330
11N/30E-02R01	4.70	609	124.00 I	ALLEN	HAILEY	993 BLANTON ROAD	ELTOPIA WA. 99330
11N/30E-03L01	7.60	723	105.00 N	H.D.	CHRISTMAN		ELTOPIA WA. 99330
11N/30E-05N01	50.00	1420	57.00 U		PLANNERT	ELTOPIA WEST ROAD	ELTOPIA WA. 99330
11N/30E-10R01	5.40	582	115.00 N	ERNEST	BAKER	50 ELTOPIA DRIVE	ELTOPIA WA. 99330
11N/30E-11A01	8.60	833	290.00 N	NORM	JACOBSON	700 BLANTON ROAD	ELTOPIA WA. 99330
11N/30E-14K01	8.30	800	265.00 N	DAVID	TUCK	251 TUCK	ELTOPIA WA. 99330
11N/30E-15R01	2.10	580	163.00 N	LARRY	SHELTON	BLK 16 UNIT 99	ELTOPIA WA. 99330
11N/30E-15C01	7.40	809	94.00 N	OLEN	SCHOCKLEY		ELTOPIA WA. 99330
11N/30E-16C01	16.00		320.00 N	HENRY	TEBBITORE	STAR ROUTE	ELTOPIA WA. 99330
11N/30E-17R01	20.00	1422	100.00 N	HENRY	TEBBITORE	STAR ROUTE	ELTOPIA WA. 99330
11N/30E-29C01	1.80	500	220.00	ROBERT	MOREMAN	BLOCK 16 UNIT 132	MATHEWS CORNER WA. 99330
11N/30E-34N01	19.00	1140	105.00 N	RICHARD	RHOADES	2881 EAST SAGEMOOR ROAD	ELTOPIA WA. 99330
12N/28E-12N01	0.10	463	450.00 N	CLARENCE	PHIPPS JR.	BLOCK 20 UNIT 162	BASIN CITY WA. 99320 WITHIN 3 MI OF ZOO AREA BOUNDARY
12N/28E-23N01001	0.10	398	413.00 N	FISHERIES	DEPT. OF	600 EAST MAPLE	BURBANK WA. WITHIN 3 MI OF ZOO AREA BOUNDARY
12N/29E-01A01	15.00	1025	313.00 N	RUSSEL	CHASE	BLOCK 19 UNIT 47	BASIN CITY WA. 99343
12N/29E-11N01	0.09	313	212.00 N	ROGER	DANZ	BLOCK 19 UNIT 95	BASIN CITY WA. 99343
12N/29E-34K01	0.10	382	971.00 N	C.	RUSSEL	543 GLENWOOD	PASCO WA. 99301
12N/30E-04D01		1110	290.00 N	RUSSEL	KAWS		BASIN CITY WA. 99343
12N/30E-04L01	7.60	1090	250.00 N	MARY	BELL	350 BAART ROAD	MEGA WA. 99343
12N/30E-05R01	8.80	750	457.50 N	CHAS L LEE	50 COL BSN I D	402 WEST LEVIS	PASCO WA. 99301
12N/30E-16L01	14.00	960		KEN	HEINEN	250 IRONWOOD LANE	ELTOPIA WA. 99330
12N/30E-21G01	11.00	1090	211.00 N	C.R.	HOBBS	370 IRONWOOD LANE	ELTOPIA WA. 99330
12N/30E-33R01	14.00	1139	374.00 N	DONALD	DIDIER	444 HOLLY DRIVE	ELTOPIA WA. 99330
12N/30E-34N01	17.00	970	328.00 N	GEORGE	O'NEIL		ELTOPIA WA. 99330
13N/29E-08N01	0.09	448	453.00 N	CURRENT	RESIDENT	ROUTE 1 BOX 175	OTHELLO WA. 99344
13N/29E-27D01	4.90	845	75.00 N	GEORGE	MATSUMURA	1870 FAIRWAY	BASIN CITY WA. 99343
13N/29E-28A01	3.50	725	25.00 N	MRS.	SCHROEDER	8471 ROAD	MEGA WA. 99343

FRANKLIN
COUNTY

Ref 10.4

9413218.0951

REFERENCE 11

Memo to file from BW Mercer on 8-14-87, Drinking Water Wells in
Franklin County Within 3 Miles of the 200 Area and Within 3
Miles of the 300 Area Defined Boundary

94328.0052
607.07246



Battelle

Pacific Northwest Laboratories

Project Number _____

Internal Distribution

File/LB

Date August 25, 1987

To File

From B. W. Mercer *Carl Lamer for BWM*

Subject Drinking Water Wells in Franklin County within 3
Miles of the 200 Area Defined Boundary and within 3
miles of the 300 Area Defined Boundary

Mr. Clifford L. Bates of the Benton Franklin District Health Department was contacted on the above date for information on the number of drinking water wells within the subject boundaries. Mr. Bates has a map of Franklin County in his office showing the location and nitrate levels of drinking water wells that he is aware of. There may be other wells that have not been reported. The number of wells within 3 miles of the 200 Area defined boundary and within 3 miles of the 300 Area defined boundary are tabulated on the following pages which also give estimates of the number of people served.

BWM:DAL:dar

To File
August 25, 1987
Page 2

Wells within 3 Miles of 200 Area Plume in the Columbia River

- Boundary: 1) North edge of T. 12 N. on an east-west line with Klamath Rd.
2) East boundary north-south along Taylor Flats Rd.
3) West boundary - Columbia River
4) South boundary - Sagemoor Rd.

Total No. of wells within this boundary is 17 including private dwellings and community wells(3). Private single dwelling wells = 14.

No. of community wells (from State of Washington Public Water Supply System Listing)

	<u>Permanent People</u>	<u>Migrant Farm Worker Residents</u>	
1. Eppich Water System	12	8	
2. Cypress Gardens School	12	0	
3. Rio Vista Orchards	<u>8</u>	<u>0</u>	
TOTAL	32	8	= 40 people
assume 3 people to private single dwelling wells = 14 x 3.8 = <u>53.2 people</u>			
TOTAL			= 95.2 people

To File
August 25, 1987
Page 3

Wells within 3 Miles of 300 Area Plume

- Boundary:
- 1) North - along Dogwood Rd on line to river
 - 2) East - along Taylor Flats Rd
 - 3) West - along Columbia River
 - 4) South - along Dent Rd and line to river

Total No. of wells within this boundary is 17 including both private single dwelling wells and community wells.

No. of community wells (from State of Washington Public Water Supply System Listing)

	<u>No. People Served</u>
1. Cypress Gardens School	12
2. Rio Vista Orchards	<u>8</u>
TOTAL	20 people

assume 3.8 people at each single dwelling well:

15 wells x 3.8 people/well = 57 people

Total people single + community wells = 77 People

943210-0455

Battelle

Prepared for the Energy Research
and Development Administration
under Contract E-77-1-0000

July 1977

Keith J. Yandon

A Research Report for the
Rockwell Hanford Operations

Hanford Reservation
Area Worker Census

TABLE 1. Concentration of Hanford Reservation Workers by Site

<u>Site</u>	<u>Number of Workers</u>	<u>Percent of Total</u>
100	750	5
200 E&W	2,355	16
WPPSS #1, 2, & 4	2,905	20
FFTF	2,420	16
300	3,110	21
Battelle, et al.	3,345	22
TOTAL	14,895	100

While the worker counts being reported by Reservation employers are usually shown concentrated around a designated site, in reality a substantial portion of these workers are likely to be distributed over the surrounding area. For convenience, however, they are credited to such particular sites as 200 East, 200 West, WPPSS 1, 2, & 4, etc.

Identification of shift workers posed some reporting difficulties since some firms run four shifts while most of the others conduct their operations in three. The 100 Area was a special problem since these workers operate over a wide area. Regardless, all workers have been accounted for in this census although some of the shift counts may be approximate.

DISTRIBUTION OF WORKERS BY RADII AND COMPASS DIRECTION

Figure 2 maps the distribution of Hanford Reservation workers by work shift over intervals of one-mile radii and 16 compass directions centered at the Purex Plant. These same worker distributions are repeated in Figure 3 without the mapped Reservation Area as a background. As a tabulating convenience, sector parcel counts have been rounded to units of 5 and 10, but were adjusted to the total count for the separate companies. (Because of confidentiality, worker counts for the separate companies are not being presented here.) For better readability, sector counts within the first two mile radii from the Purex Plant center are presented separately at the bottom of the figure. Table 2 presents work distribution in detail including a cumulative count of workers and percent of total as distance and direction from the Purex Plant center increases.

REFERENCE 13

Waste Management Operations, Hanford Reservations,

ERDA-1538, December 1975

94320-000

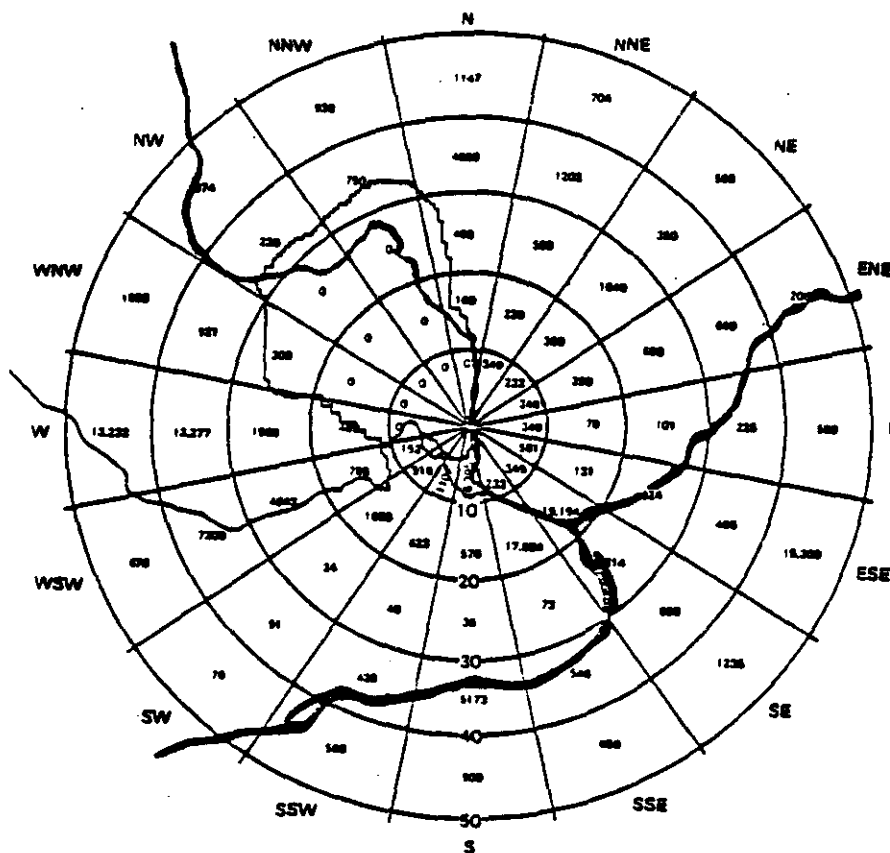


FIGURE II.3-4 ESTIMATED GEOGRAPHIC DISTRIBUTION OF THE 1970 POPULATION (162,000) WITHIN A 50-MILE RADIUS OF THE 300 AREA

The nature and extent of present land use is discussed here on the basis of arcs described from the HMS. Land areas included in a 50-mile radius from the other two site areas are also covered.³ Figure II.3-5 is an aerial photograph in which the general pattern of agricultural usage is visible as the darker, regular-shaped areas.

Figure II.3-6 shows the Hanford site map with sector markings overlaid. Starting from a line directly north from the HMS, the 0- to 10-mile zone is entirely within the Hanford site boundaries. The area south of the Columbia River is under ERDA control and is a limited access area. Land north of the river is controlled by the Bureau of Sport Fisheries and Wildlife as a game refuge. All of this zone between the 0- and 150-degree radials is limited access area under control of ERDA. Most of the zone between the 150- and 270-degree radials consists of the Arid Lands Ecology (ALE) Reserve, which is also limited access ERDA land under the control of Battelle, Pacific Northwest Laboratories. Between the 270-degree radial and the starting radial, land south of the Columbia River is ERDA-controlled limited access while north of the river the game refuge is again encountered.

Again starting from the 0-degree radial, the 10- to 20-mile zone is a continuation of the game refuge with some areas open for fishing, shotgun and bow hunting during daylight hours. Further north, this zone includes the eastern-most portion of the Wahluke Slope and the Saddle Mountains. Between the Wahluke Branch Canal and the Columbia River, the zone consists of lands in the Columbia Basin Project which are irrigated or are being developed for irrigation. The area west of the river is limited access Hanford site. Leaving the site boundary, the land is mainly unirrigated land used for grazing cattle and sheep. South and west of the Columbia River, in the vicinity of Priest Rapids Dam, is the U.S. Army Yakima Firing Range which is undeveloped, unpopulated land. Northwest of Priest Rapids Dam and Reservoir is the Wahluke Slope portion of the Columbia Basin Project. This area is partially irrigated with the rest (outside the Hanford Reservation) expected to be irrigated in the next 10 years.

- Trilateration measurements are performed between 17 benchmarks to measure crustal motion. The initial base data were developed 3 years ago, with additional measurements at 6 months, 12 months, and 36 months from that time.
- Tiltmeters are installed at three locations on the Hanford Reservation. These pieces of equipment provide continuous geographic coverage of crustal motion. The output is telemetered to Menlo Park for interpretation.

Figure II.3-9 shows the active earthquake zones in Washington deduced from earthquake activity. East of the Cascades the trends are largely north-south, parallel to the Cascades, and divide the state into separate geographical, structural and tectonic provinces.

In eastern Washington, clearcut relationships of epicenters to specific surface faults or structures capable of faulting are not yet recognized. The suggested low rate of tectonic deformation for more than 10 million years¹⁹ does not indicate any cause for concern. Much of the stress resulting from the continuing low rate of tectonic deformation appears to be dissipated from random epicenters along joints and bedding planes.

On the assumption that an MM-VII quake (magnitude 5.5) were to occur at the northwest end of the Rattlesnake-Wallula fault zone, ground acceleration of 13% g could be expected beneath most of the Hanford Reservation.³¹ A design basis of 25% g on the Hanford Reservation thereby allows for an MM-VIII intensity quake (magnitude up to 6.8) for an earthquake epicentered at the same site. No such quake has ever been recorded in eastern Oregon or Washington.

The siting of nuclear facilities over the synclinal troughs assures the maximum distance from all hypothesized faults capable of earthquake generation. If, in addition, the Ringold Formation and Pasco Gravels are compact and undisturbed, the site is certain to pose few problems. An appreciable to high degree of conservatism appears present by acceptance of the MM-VIII quake (magnitude 6.8) and the resulting 25% g acceleration for facility design purposes.

II.3.8 Hydrology^(a) [RPB, X.18, X.25]

II.3.8.1 Surface Water

The surface water bodies located within the boundaries of the Hanford Reservation consist of the Columbia River, various ditches and ponds in and near the 200 Areas and three ponds located in the 300 Areas (Figure II.3-10). Two ephemeral streams, Cold and Dry Creeks, appear for a short time only after heavy rainfall or snowmelt. The Yakima River borders part of the Reservation's southern boundary.

II.3.8.1.1 Columbia River

The river reach from Priest Rapids Dam (river mile 397) to the head (approximately river mile 351) of the reservoir behind McNary Dam is the last free-flowing reach of the Columbia River within the United States. The main channel is braided around the island reaches, and submerged rock ledges and gravel bars cause repeated pooling and channeling. The riverbed material is mobile, dependent on river velocities; it is typically sand, gravel, and rocks up to 8 inches in diameter. Small fractions of silts and clays are associated with the sands in areas of low velocity deposition, becoming more dominant approaching the upstream face of each river dam.^{32,33,34}

The Columbia River in this reach has widely varying flow rates due to regulation by the power producing Priest Rapids Dam just upstream (Figure II.3-11). Flows during the summer, fall and winter vary from a low of 36,000 cubic feet per second (cfs) to as much as 160,000 cfs each day. The long-term annual average flow at Hanford is about 120,000 cfs,³⁵ but during low flow periods, daily flows average 80,000 to 90,000 cfs. The mean annual flow rate for 1972 at Hanford was 159,500 cfs. In recent years, peak flows during the spring runoff have ranged from 160,000 to 550,000 cfs; the maximum flood peak of record is 693,000 cfs in 1948.

The river width in the Hanford reach varies between 400 and 600 yards depending upon flow rate and position along the river.³⁶ The depth at the deepest part of the measured cross-sections varies approximately from 10 to 40 feet, with an average around 25 feet. Daily fluctuations in depth caused by Priest Rapids regulation can be as much as 10 feet above Vernita and 5 feet at Hanford. The maximum velocities measured vary from less than 3 feet per second (fps) to over 11 fps, again depending upon the river cross-section and flow rate.

(a) Appendix II.3-D provides a more detailed description of the hydrology of the Hanford Reservation. In 1973 Atlantic Richfield Hanford Company authorized an independent review, recently completed, of the hydrology program.

REFERENCE 14

Draft Environmental Impact Statement, Disposal of
Hanford Defense High-Level, Transuranic and Tank Waste,

DOE/EIS-0113, Volume 1

9403210.0462

Badgers are present in low numbers in the 200 Areas plateau. The coyote is the principal mammalian predator on the Site. Elk are found on the Rattlesnake Hills to the southwest of the 200 Areas. Mule deer are abundant on the western part of the Site. They occasionally use the waste ponds and associated riparian vegetation near the 200 Areas for food and water. Mule deer tagged along the Columbia River have moved as far as 48 km from the Site (Fitzner and Price 1973).

4.6.2 Aquatic Ecology

Aquatic habitats on the Site include the ponds and ditches in or near the 200 Areas, the Columbia River, and two very small streams formed by Rattlesnake Springs and Snively Springs west of the 200 Areas plateau (Figure 4.7). Ponds found in or near the 200 Areas are Gable Mountain Pond, which is undergoing decommissioning, and B Pond, which receives cooling water from the 200-E Area encapsulation facility (Emery and McShane 1980; Meinhardt and Frostenson 1979). The wastewater disposal sites have similar water-quality characteristics, and support similar kinds of algae, rooted plants, and invertebrates; all contain introduced populations of goldfish. West Pond (created by the rise in the water table in the 200 Areas) is very alkaline, has a much lower density and diversity of plants and animals, and has no fish. The ponds and ditches are the only sources of water in the arid environment of the 200 Areas plateau and therefore provide habitat for many birds and mammals. The ditches are generally less productive than the ponds in terms of biomass per unit area of bottom or unit volume of water. Streams formed by Rattlesnake and Snively Springs are quite productive but are remote from the waste sites.

The Columbia River is the largest surface water and supports the most important aquatic ecosystem on the Site (ERDA 1975). Much of the river has been impounded by hydroelectric dams, and the section of river on the Site is the last non-tidal free-flowing reach in the United States. Forty-five species of fish have been identified from the Hanford reach of the river (Gray and Dauble 1977). Several species of economically important salmon and the steelhead trout use the river to migrate to and from upstream spawning and rearing areas. Fall chinook salmon and steelhead trout spawn on the Site. The Hanford site serves as the spawning area for more than one-third of the fall chinook salmon in the mid-Columbia (Watson 1970).

4.6.3 Threatened and Endangered Species

Endangered and threatened plants and animals on the Site, as designated by both the federal and State of Washington agencies, are listed in Table 4.12. There are no endangered or threatened plant species on the Site, although several species are listed as candidates for endangered or threatened status or for classification as "sensitive."

Both the federal and state authorities consider the peregrine falcon to be an endangered species and the bald eagle a threatened species. The state also classifies the white pelican as endangered and the ferruginous hawk and the pygmy rabbit as threatened.

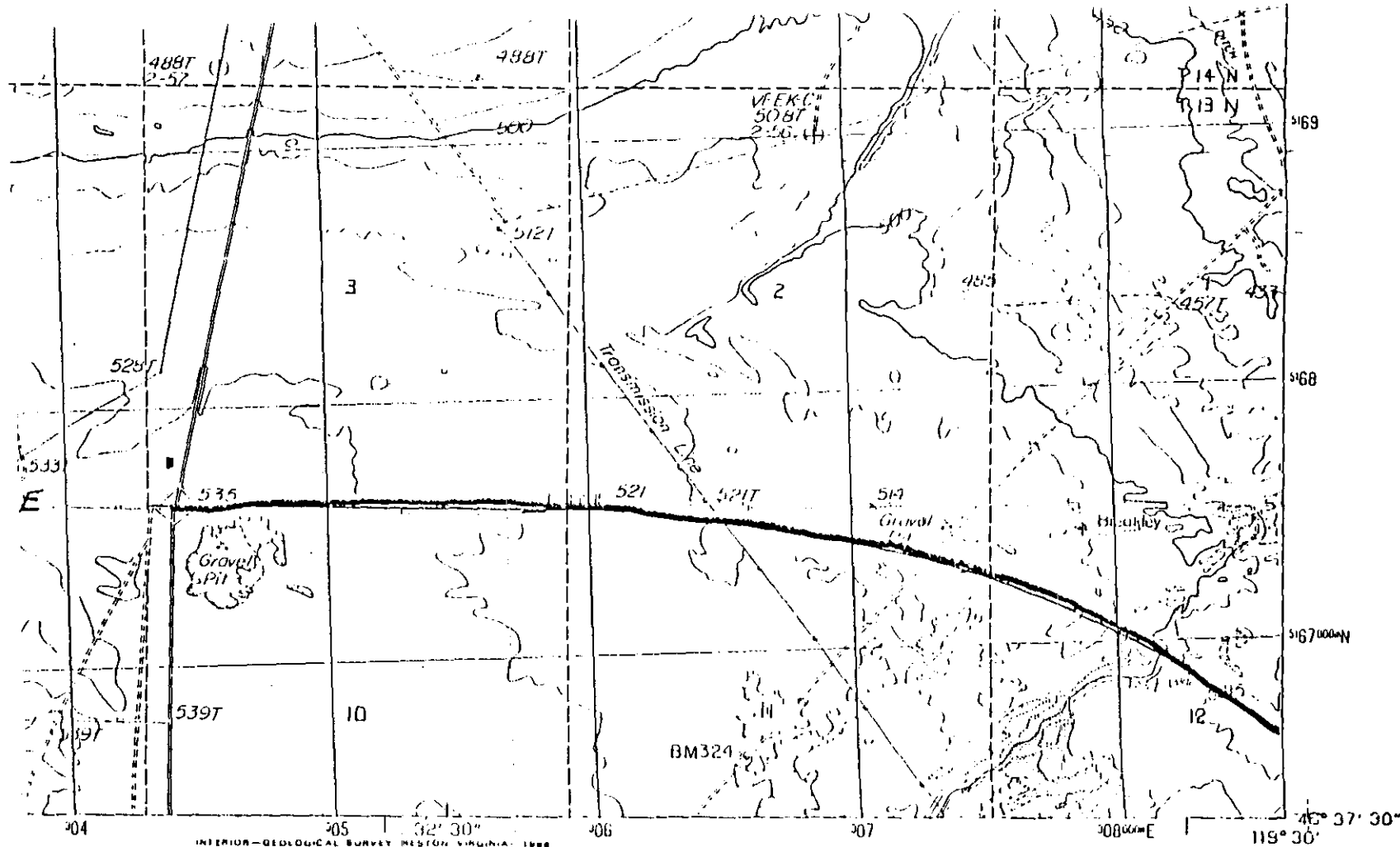
The bald eagle is fairly common along the Hanford reach of the Columbia River during fall and winter, when it feeds on the carcasses of spawned-out salmon (Fitzner et al. 1981).

REFERENCE 15, 16 and 17

U.S.G.S. Maps Showing 200 Area Surroundings

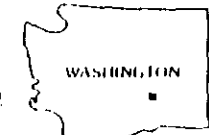
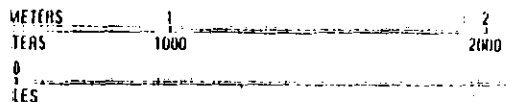
Gable Butte, Wash 7.5 Minute Map
Coyote Rapids, Wash 7.5 Minute Map
Locke Island, Wash 7.5 Minute Map
Vernita Bridge, Wash 7.5 Minute Map
Snively Basin, Wash 7.5 Minute Map
Iowa Flats, Wash 7.5 Minute Map
River Island, Wash 7.5 Minute Map
Horn Rapids Dam, Wash 7.5 Minute Map
Richland, Wash 7.5 Minute Map
Wooded Island, Wash 7.5 Minute Map
Columbia Point, Wash 7.5 Minute Map
Hanford, Wash 7.5 Minute Map
Savage Island, Wash 7.5 Minute Map
Basin City, Wash 7.5 Minute Map
Mathews Corner, Wash 7.5 Minute Map

943213.1466



2
36/22

1:24 000



QUADRANGLE LOCATION

BRVAL 10 FEET

V TO THE NEAREST 0.1 FOOT
N TO THE NEAREST FOOT
or multiply by 3.2808
or multiply by 0.3048

1	2	3	1 Smyrna
			2 Wahutis Peak
4		5	3 Coru
			4 Vernita Bridge
			5 Locke Island
6	7	8	6 Riverland
			7 Gable Botte
			8 Handford

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

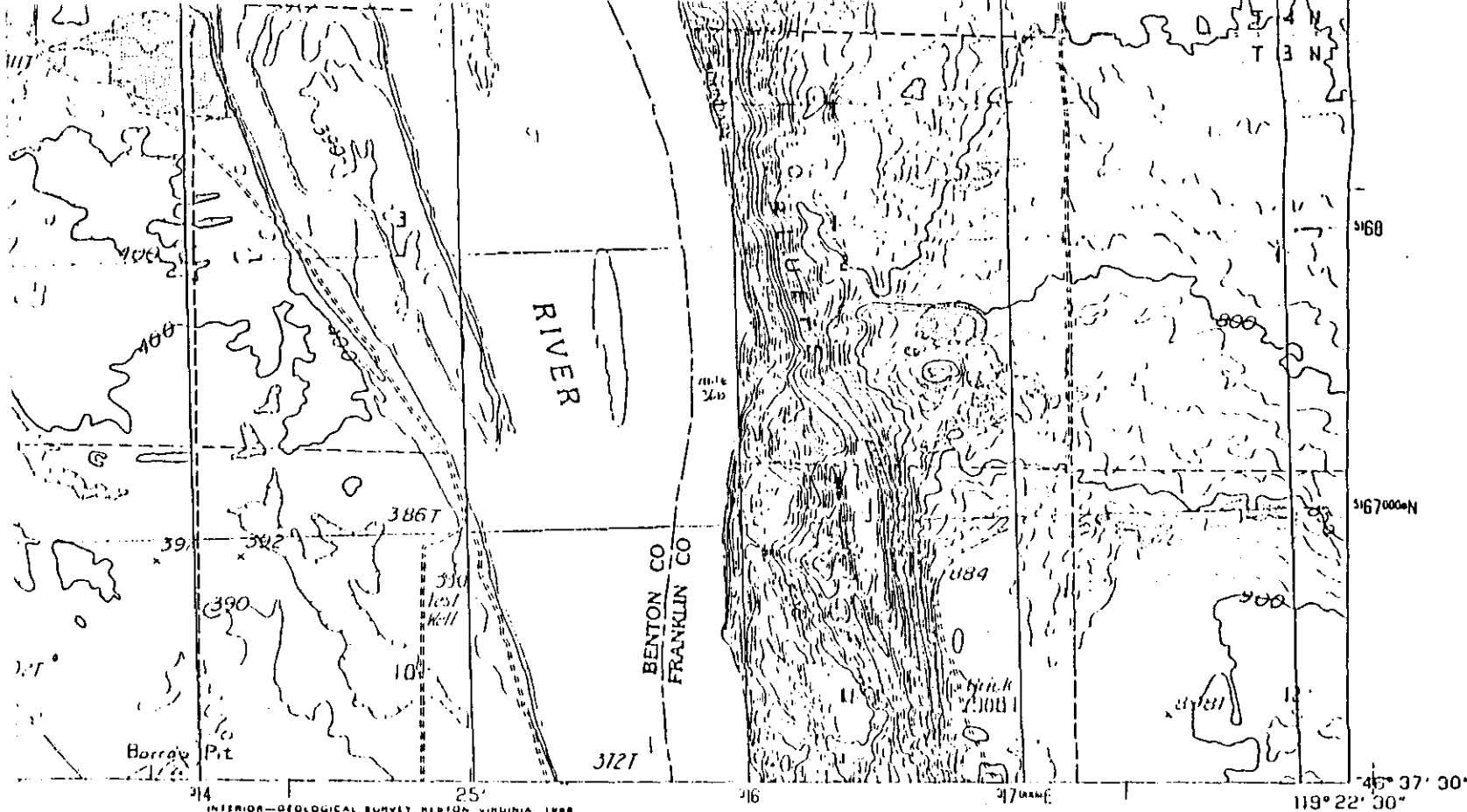
- Improved Road.....
- Unimproved Road.....
- Trail.....
- Interstate Route □ U.S. Route ○ State Route

COYOTE RAPIDS, WASH.
PROVISIONAL EDITION 1986

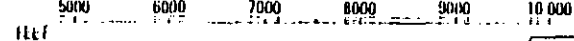
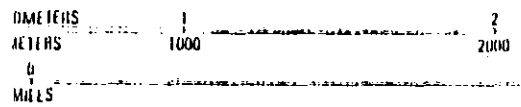
NAL MAP ACCURACY STANDARDS
R, COLORADO 80225, OR RESTON, VIRGINIA 22092

46119-F5-TF-024

3
36122



1:24 000



INTERVAL 10 FEET

DOWN TO THE NEAREST 0.1 FOOT
DOWN TO THE NEAREST FOOT

feet multiply by 3.2808
meters multiply by 0.3048

ADJACENT MAP ACCURACY STANDARDS
FED. COLORADO 80225, OR RESTON, VIRGINIA 22092



QUADRANGLE LOCATION

1	2	3	1 Wahalla Peak
			2 Corfu
			3 Taunton
4		5	4 Coyote Rapids
			5 Hanford NE
			6 Gable Flats
6	7	8	7 Hanford
			8 Savage Island

ADJACENT 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road.....

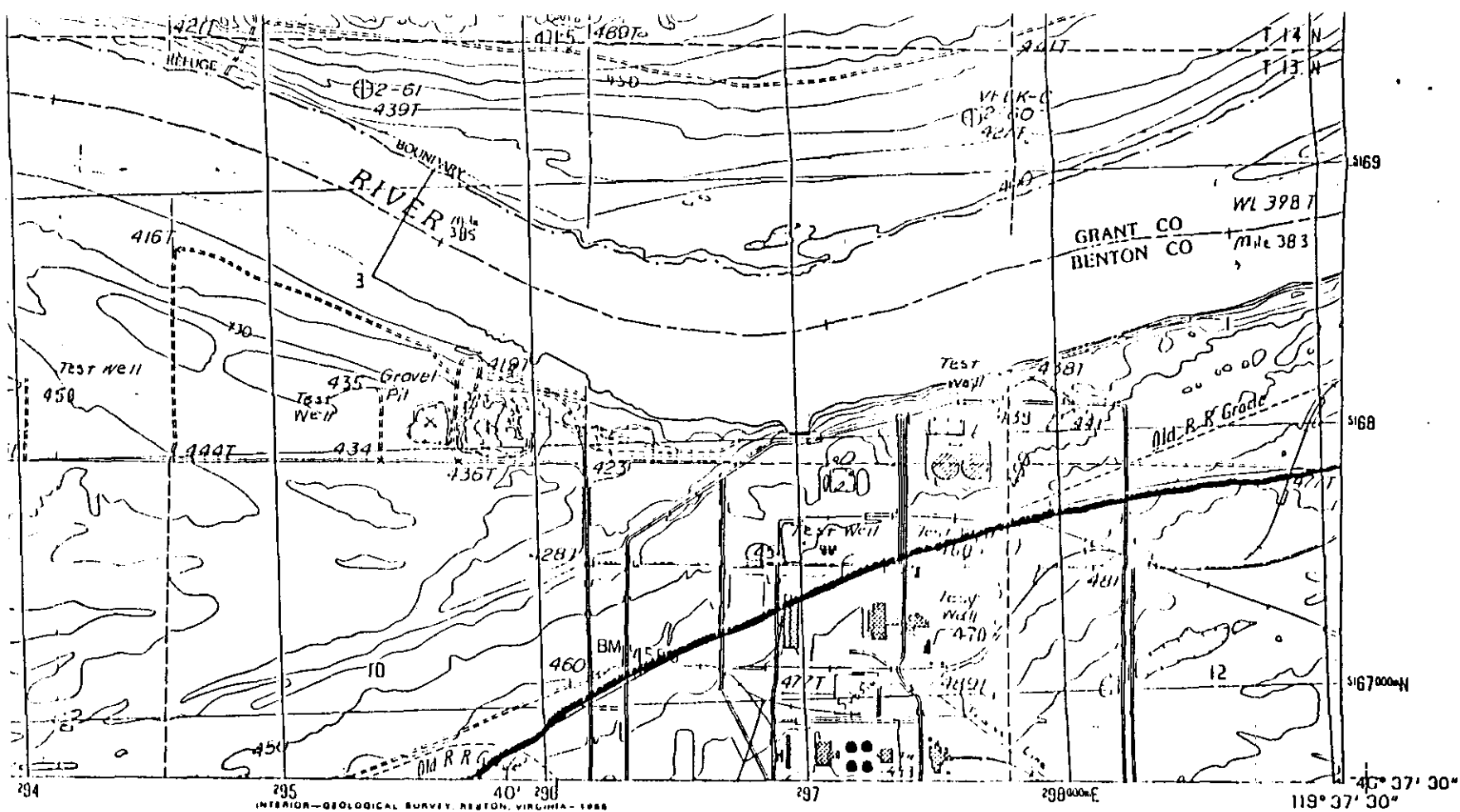
Unimproved Road.....

Trail.....

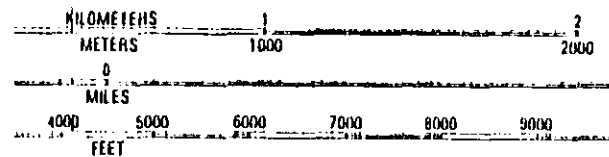
() Interstate Route } } U.S. Route () State Route

LOCKE ISLAND, WASH.
PROVISIONAL EDITION 1986

46119-F4-TF-024



SCALE 1:24 000



OUR INTERVAL 10 FEET

ONS SHOWN TO THE NEAREST 0.1 FOOT
IONS SHOWN TO THE NEAREST FOOT
it meters to feet multiply by 3.2808
it feet to meters multiply by 0.3048

ITH NATIONAL MAP ACCURACY STANDARDS
Y, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092



QUADRANGLE LOCATION

1	2	3	1 Beverly SE
4		5	2 Smyrna
			3 Whitts Peak
			4 Pylet Rapids NE
			5 Coyote Rapids
6	7	8	6 Emerson Nipple
			7 Riverland
			8 Gable Butte

ADJOINING 7.5' QUADRANGLE NAMES

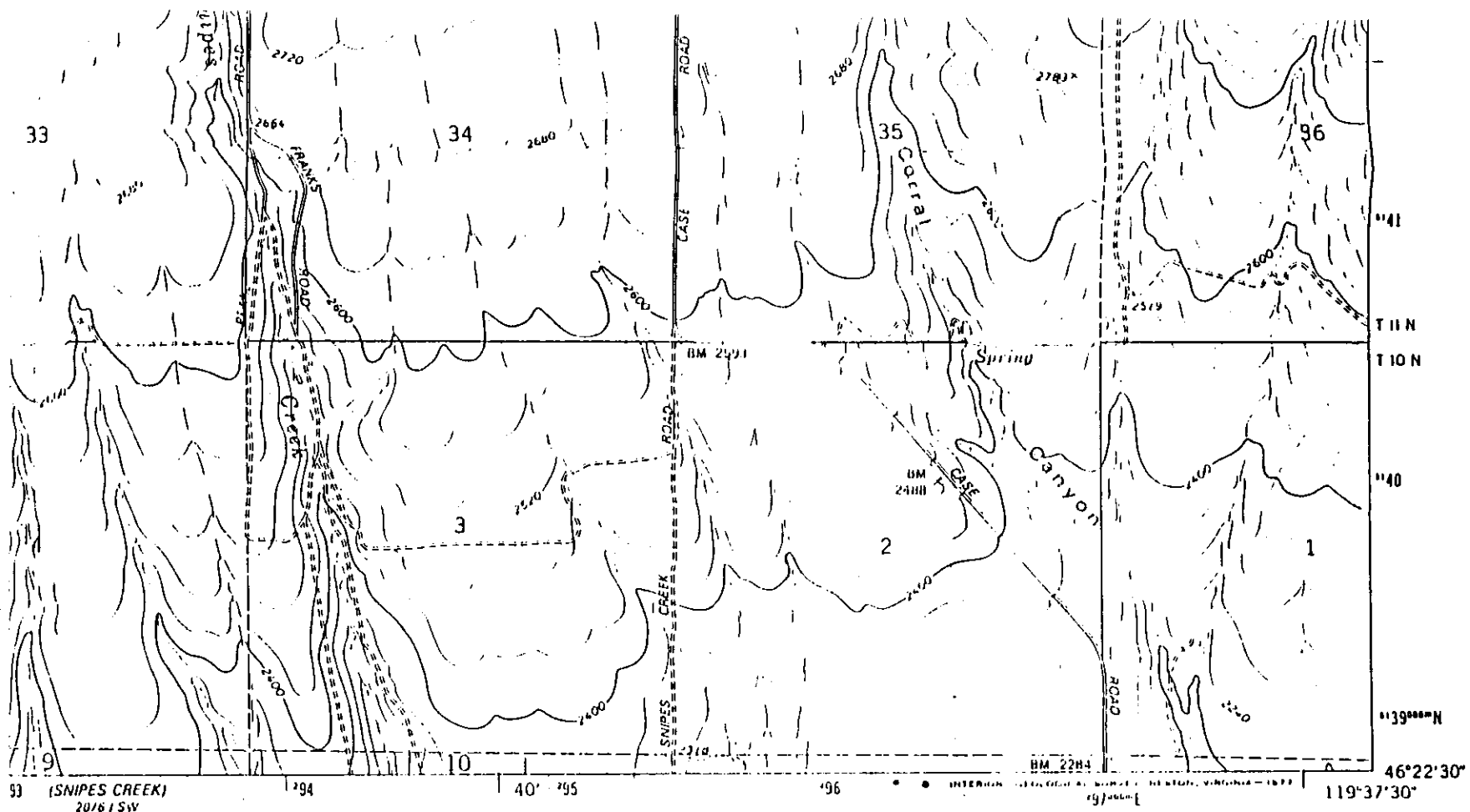
ROAD LEGEND

Improved Road.....
Unimproved Road.....
Trail.....
○ Interstate Route ○ U.S. Route ○ State Route

VERNITA BRIDGE, WASH.

PROVISIONAL EDITION 1986

46119-F6-TF-024



WITH NATIONAL MAP ACCURACY STANDARDS
 U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
 MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

SNIVELY BASIN, WASH.

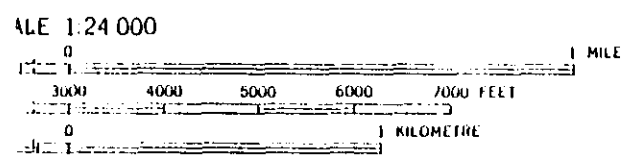
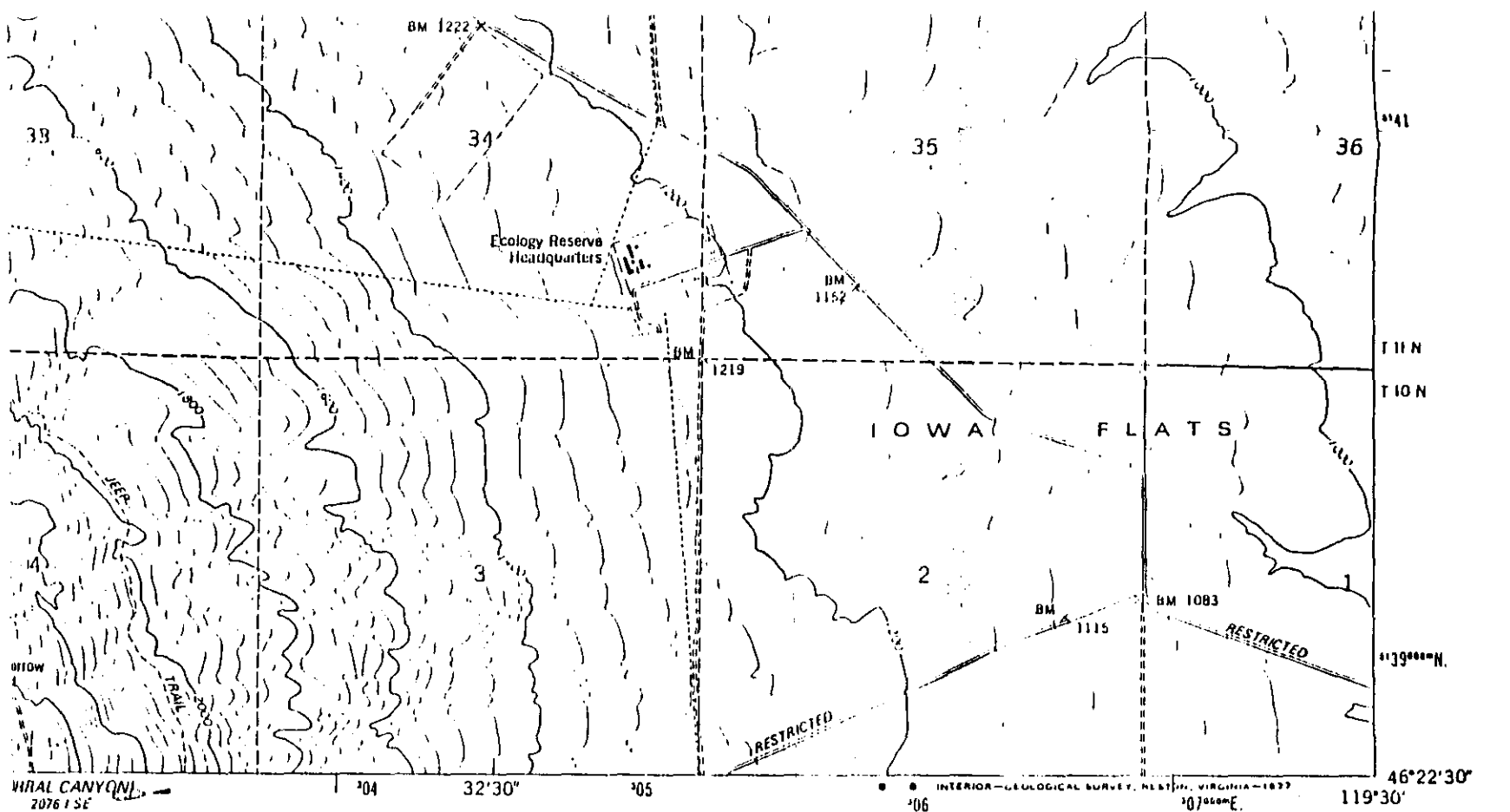
NW/4 CORRAL CANYON 15' QUADRANGLE
 N4622.5—W11937.5/7.5

1974

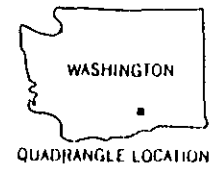
AMS 2078 1 NW—SERIES V891

5
 36/22

36122



INTERVAL 40 FEET
PRESENT 20-FOOT CONTOURS
IC VERTICAL DATUM OF 1929



ROAD CLASSIFICATION

Primary highway, hard surface	Light duty road, hard or improved surface
Secondary highway, hard surface	Unimproved road

() Interstate Route { } U. S. Route ○ State Route

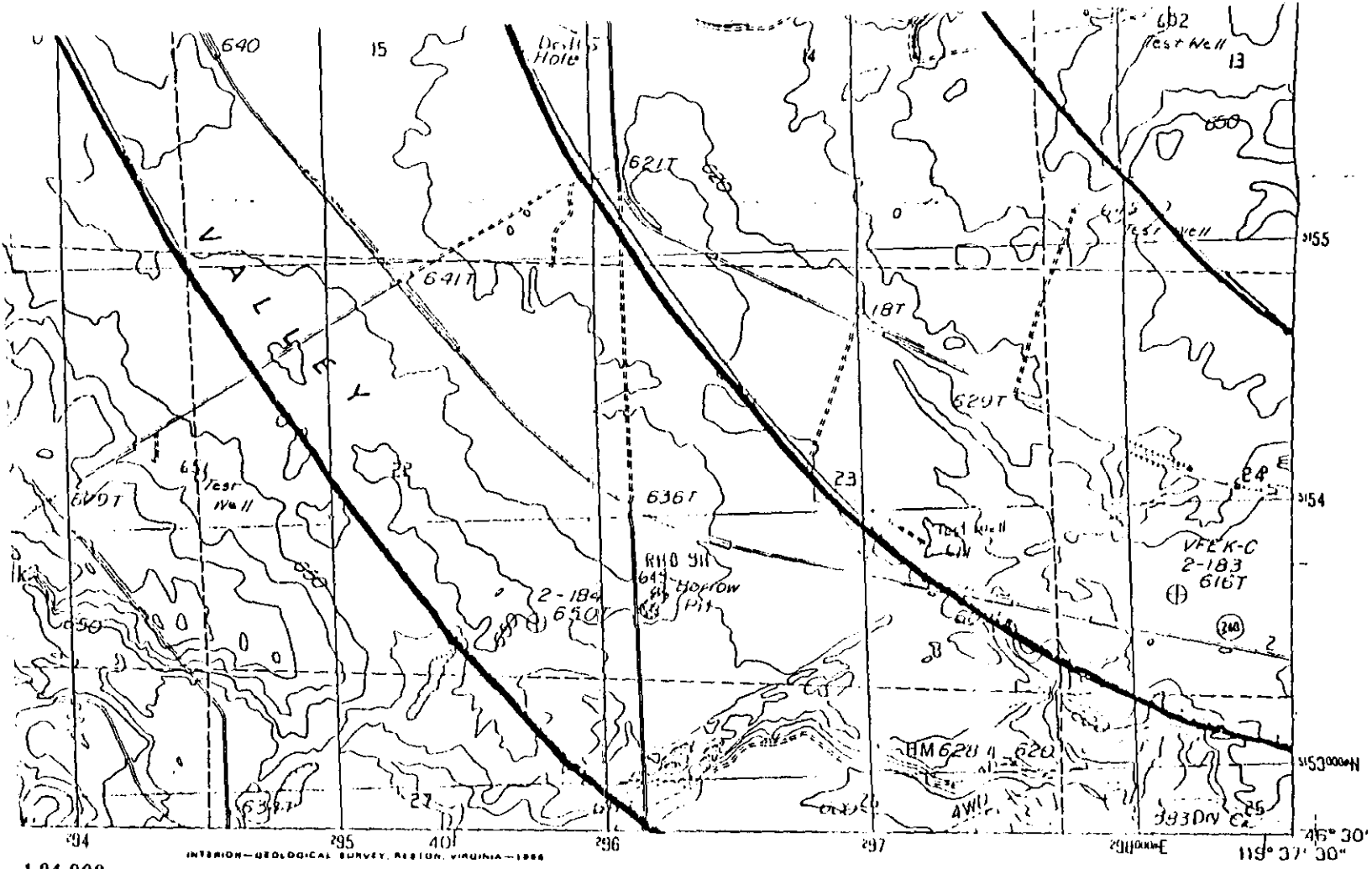
IOWA FLATS, WASH.
NE/4 CORRAL CANYON 15' QUADRANGLE
N4622.5--W11930/7.5

1974

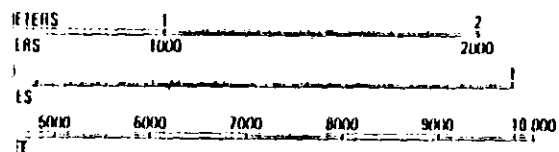
AMS 2078 I NE--SERIES V891

NATIONAL MAP ACCURACY STANDARDS
NVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

361227



1:24 000



RVAL 10 FEET

TO THE NEAREST 0.1 FOOT
TO THE NEAREST FOOT

x multiply by 3.2808
x multiply by 0.3048

1	2	3	1 Priest Rapids NE
4		5	2 Vernia Bridge
6	7	8	3 Coyote Rapids
			4 Emerson Nipple
			5 Gable Butte
			6 Malien Spring
			7 Sively Basin
			8 Iowa Plate

ADJOINING 7.5' QUADRANGLE NAMES

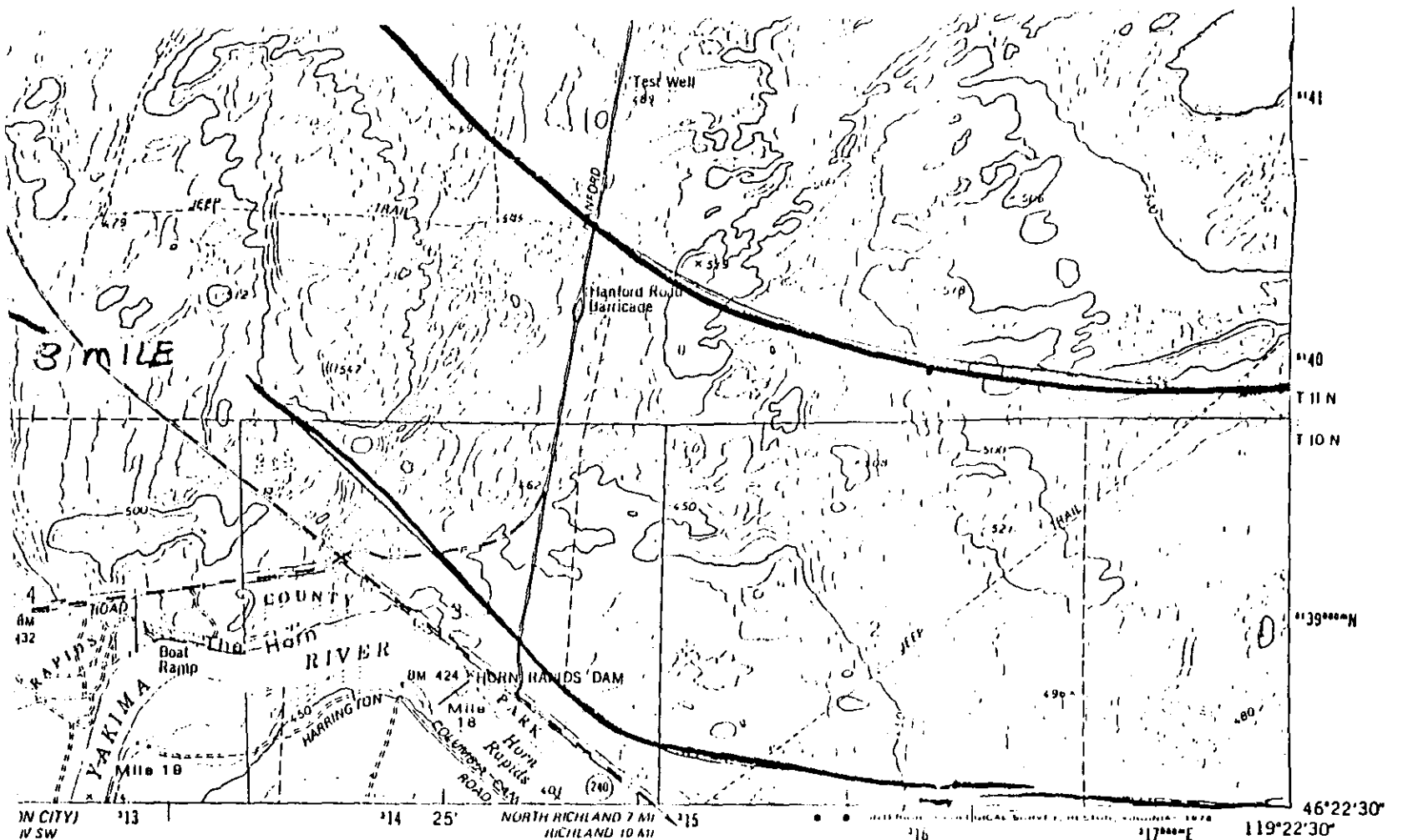
IAL MAP ACCURACY STANDARDS
I, COLORADO 80225, OR RESTON, VIRGINIA 22092

ROAD LEGEND

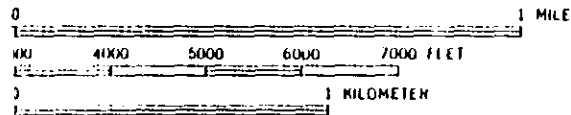
- Improved Road.....
- Unimproved Road.....
- Trail.....
- Interstate Route □ U.S. Route ○ State Route

RIVERLAND, WASH.
PROVISIONAL EDITION 1986

46119-E6-TF-024



1:24 000



VERTICAL DATUM OF 1929



QUADRANGLE LOCATION

ROAD CLASSIFICATION

Primary highway, hard surface ——— Light-duty road, hard or improved surface ———
 Secondary highway, hard surface - - - - - Unimproved road - - - - -
 ○ Interstate Route { } U S Route ○ State Route

HORN RAPIDS DAM, WASH.

NW/4 RICHLAND 15' QUADRANGLE

N4622.5—W11922.5/7.5

1977

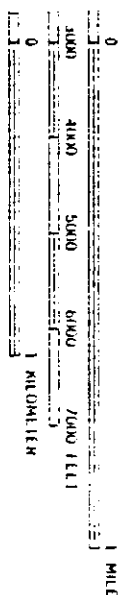
AMS 2176 IV NW—SERIES V891

NATIONAL MAP ACCURACY STANDARDS
 COLORADO 80225, OR RESTON, VIRGINIA 22092
 AND SYMBOLS IS AVAILABLE ON REQUEST

NATIONAL MAP ACCURACY STANDARDS
 FEDERAL COORDINATE 80225, OR RESTON, VIRGINIA 22092
 MAPS AND SYMBOLS IS AVAILABLE ON REQUEST



VERTICAL DATUM OF 1929



E 1:24 000

ROAD CLASSIFICATION

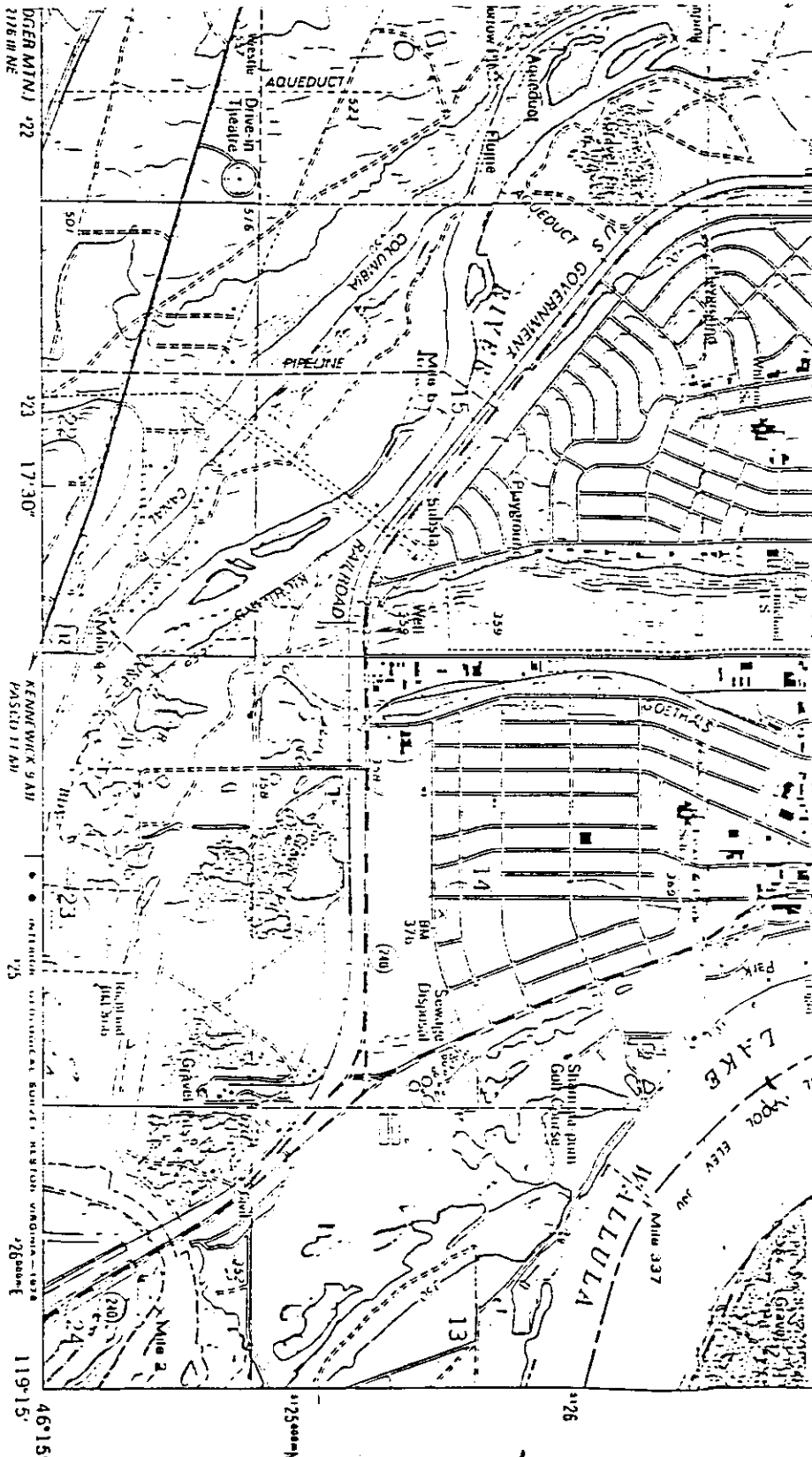
- Primary highway. ——— light duty road, hard or hard surface ——— improved surface
- Secondary highway. ——— Unimproved road
- hard surface ——— Interstate Route () State Route

RICHLAND, WASH.

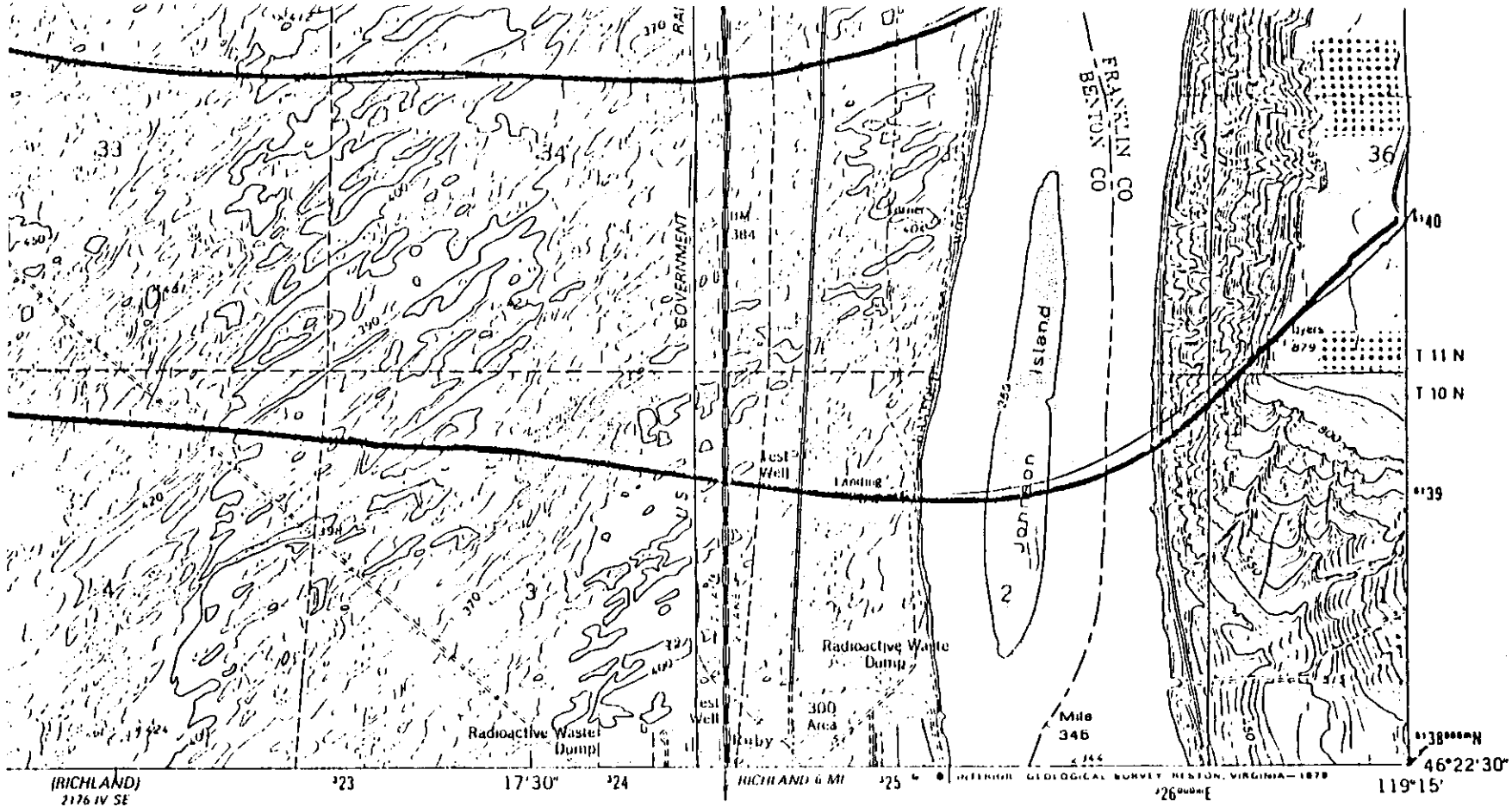
1:24 000 RICHLAND 15' QUADRANGLE
 N4615--W11915/7.5

1978

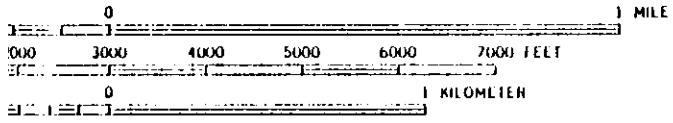
AMS 2170 IV SE--SERIES V891



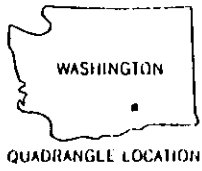
2
36122



SCALE 1:24 000



OUR INTERVAL 10 FEET
ODETIC VERTICAL DATUM OF 1929



QUADRANGLE LOCATION

ROAD CLASSIFICATION

Primary highway, hard surface: ————
Secondary highway, hard surface: - - - - -
Light-duty road, hard or improved surface: ————
Unimproved road: - - - - -

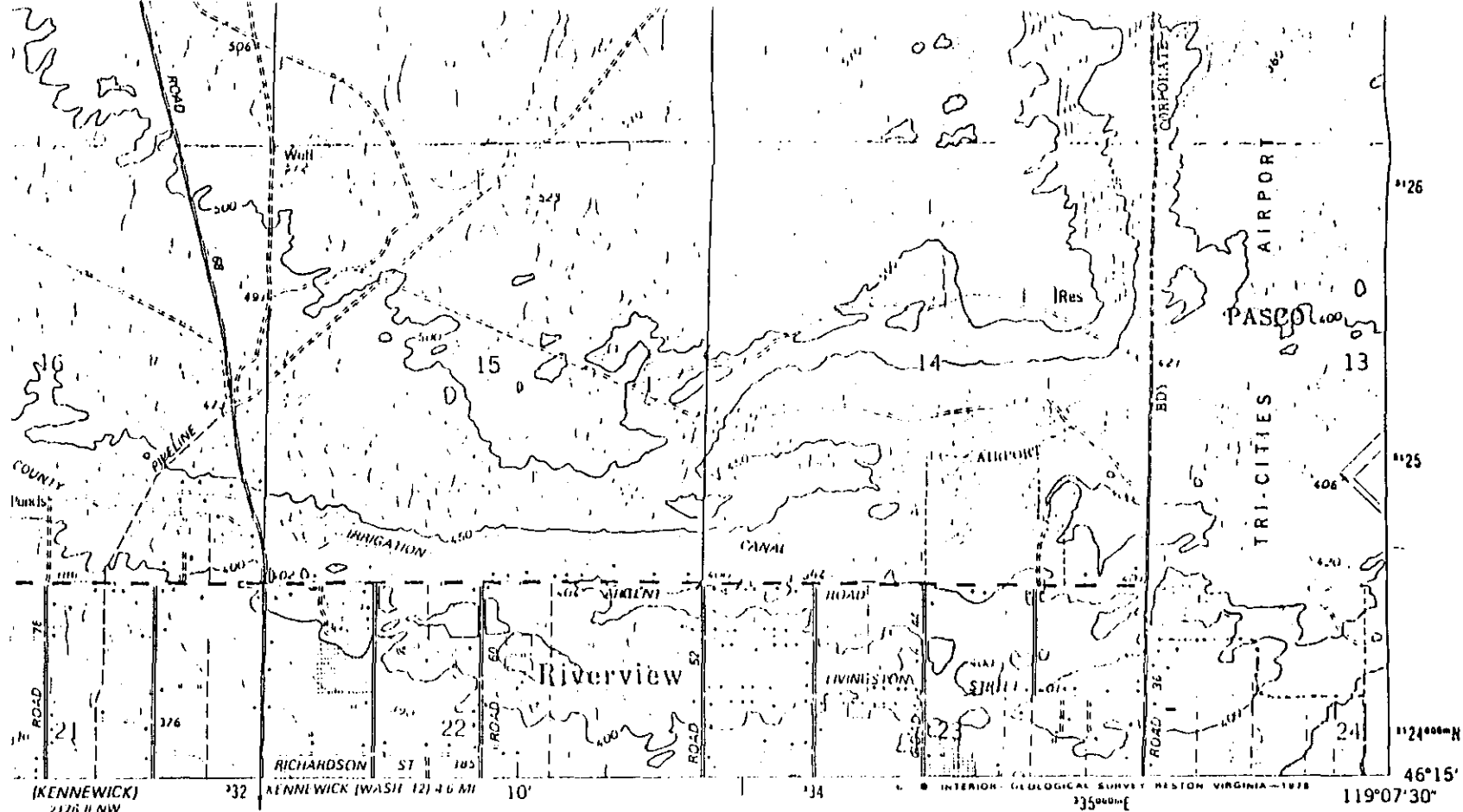
() Interstate Route { } U S Route () State Route

WOODED ISLAND, WASH.
NE 1/4 RICHLAND 15' QUADRANGLE
N4622.5—W11915.7.5

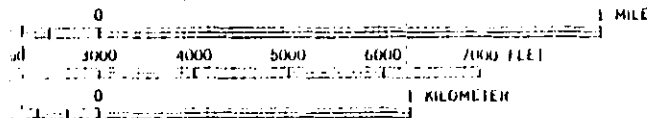
WITH NATIONAL MAP ACCURACY STANDARDS
EY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
APHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

1978

AMS 2176 IV NE—SERIES V801



SCALE 1:24 000



UR INTERVAL 10 FEET
DELTIC VERTICAL DATUM OF 1929



1:100 000 NATIONAL MAP ACCURACY STANDARDS
Y, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
PHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION

Primary highway, hard surface ——— Light-duty road, hard or improved surface
Secondary highway, hard surface - - - Unimproved road
() Interstate Route { } U S Route () State Route

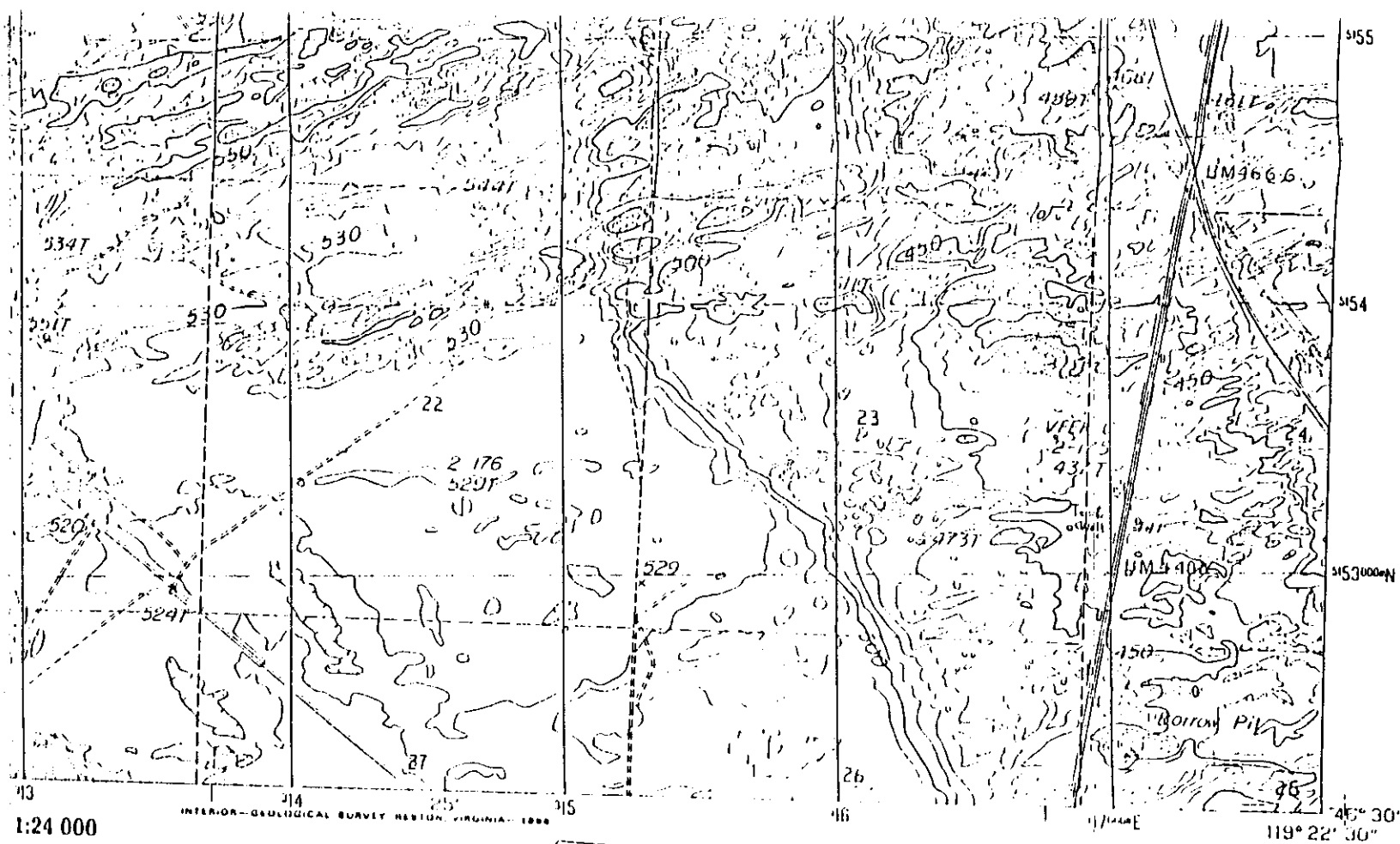
COLUMBIA POINT, WASH.

SW 1/4 ELTOPIA 15' QUADRANGLE
N4615-W11907.5/7.5

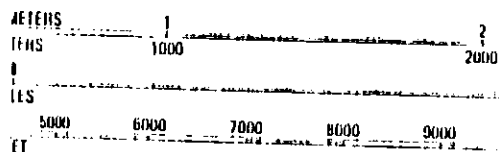
1978

AMS 2178 I SW-SERIES V801

2
36122

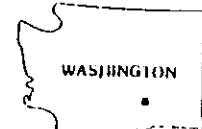


1:24 000



VERTICAL 10 FEET
HORIZONTAL 0.1 FOOT
TO THE NEAREST FOOT
at multiply by 3 2000
at multiply by 0.3048

NATIONAL MAP ACCURACY STANDARDS
H, COLORADO 80225, OR RESTON, VIRGINIA 22092



QUADRANGLE LOCATION

1	2	3	1 Coyote Rapids
4		5	2 Locke Island
6	7	8	3 Hanford NC
			4 Gable Butte
			5 Savage Island
			6 Iowa Flats
			7 Horn Rapids Dam
			8 Wooded Island

ADJOINING 7.5' QUADRANGLE NAMES

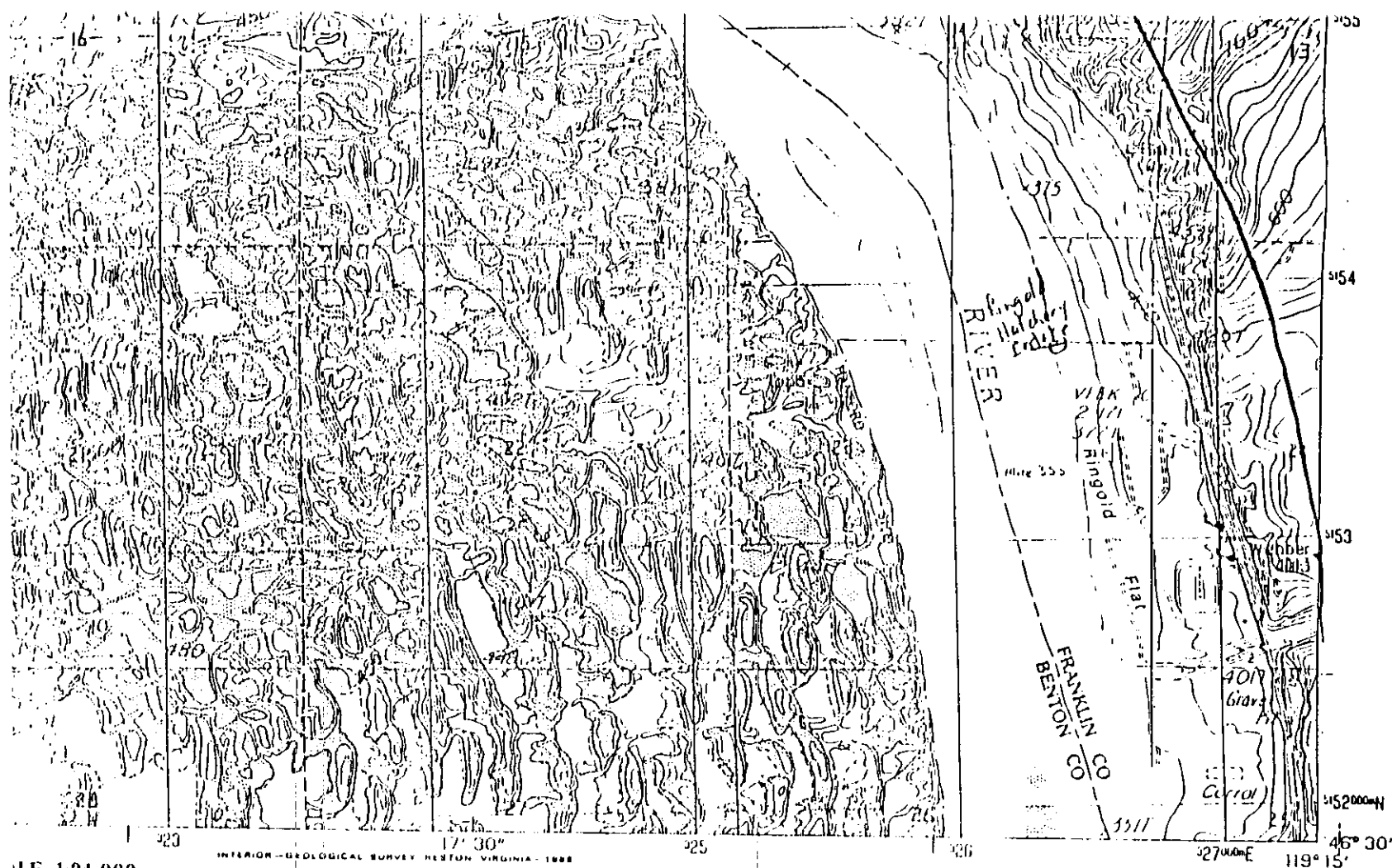
ROAD LEGEND

Improved Road.....
Unimproved Road.....
Trail.....
() Interstate Route { } U.S. Route () State Route

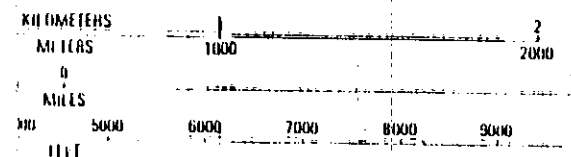
HANFORD, WASH.
PROVISIONAL EDITION 1986

46119-E4-TF-024

2
36122



SCALE 1:24 000



INTERVAL 10 FEET

SHOWN TO THE NEAREST 0.1 FOOT
SHOWN TO THE NEAREST FOOT

as to feet multiply by 3.2808
as to meters multiply by 0.3048

NATIONAL MAP ACCURACY STANDARDS
DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092



QUADRANGLE LOCATION

1	2	3	1 Locke Island
			2 Hanford NE
4		5	3 Eagle Lakes
			4 Hanford
			5 Basal City
6	7	8	6 Horn Rapids Dam
			7 Wooded Island
			8 Mathews Corner

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road.....

Unimproved Road.....

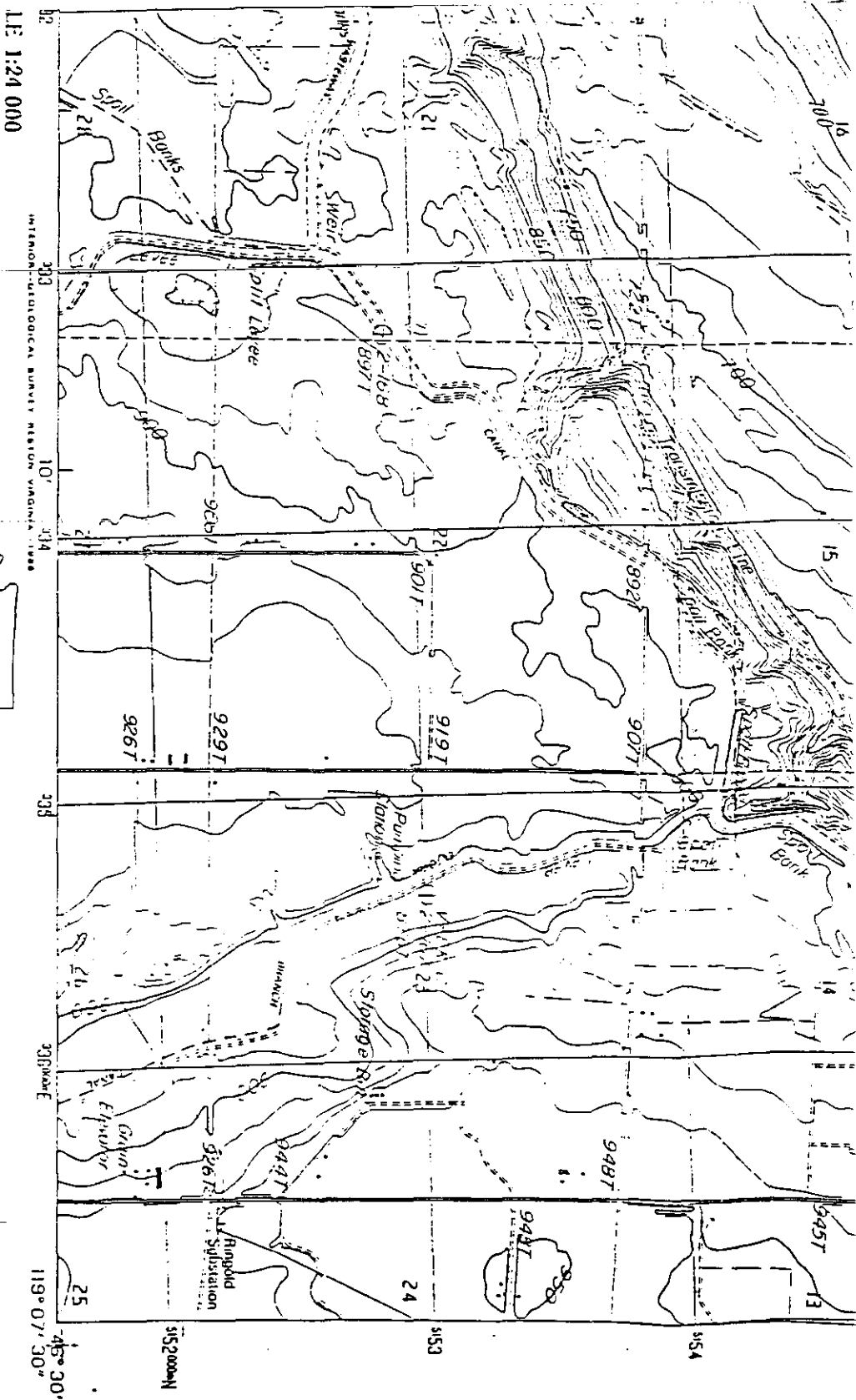
Trail.....

() Interstate Route { } U.S. Route ○ State Route

SAVAGE ISLAND, WASH.
PROVISIONAL EDITION 1986

46119.F.C.T.F.09A

36122



KILOMETERS
 METERS
 0 1000 2000
 MILES
 0 10 20
 FEET
 0 1000 2000

INTERVAL 10 FEET

1	2	3	1	1
4	5	6	2	2
6	7	8	3	3
			4	4
			5	5
			6	6
			7	7
			8	8

AERIAL MAP ACCURACY STANDARDS
 NAD 83, COORDINATE 80225, ON THE STATION, VIRGINIA 22092

ADDITIONAL 75 QUADRANTAL NAMES

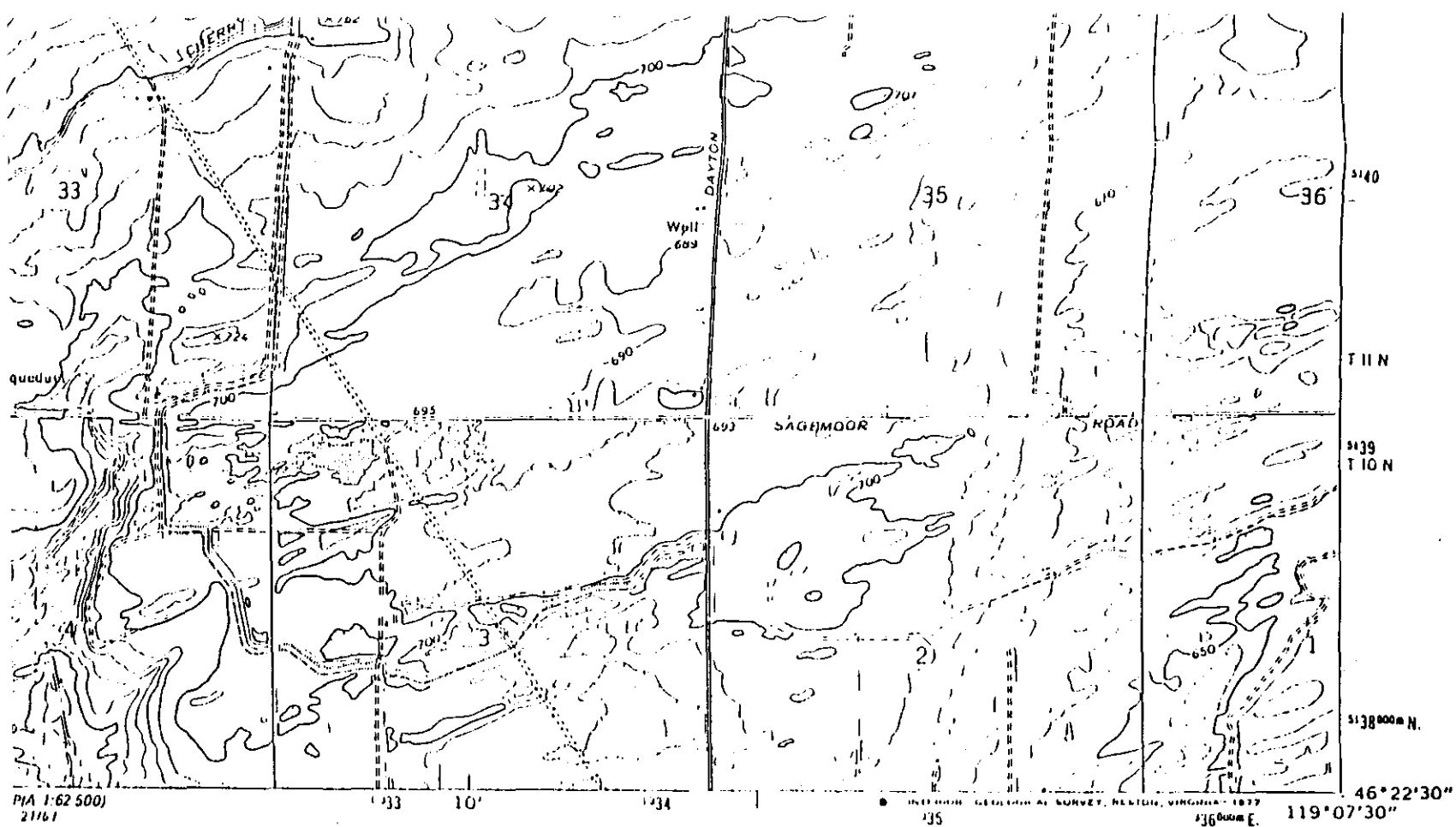
ROAD LEGEND

Improved Road
 Unimproved Road
 Trail
 () Interstate Route () U.S. Route () State Route

BASIN CITY, WASH.

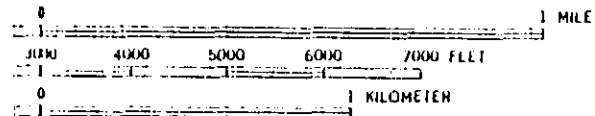
PROVISIONAL EDITION 1986

46119-02-TP-024

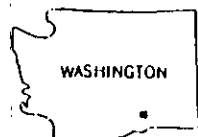


PIA 1:62 500
21161

E 1:24 000



INTERVAL 10 FEET
PRESENT 5-FOOT CONTOURS
VERTICAL DATUM OF 1929



QUADRANGLE LOCATION

NATIONAL MAP ACCURACY STANDARDS
VEIL, COLORADO 80225, OR RESTON, VIRGINIA 22092
AIDS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION

Primary highway, hard surface ——— Light-duty road, hard or improved surface ———
Secondary highway, hard surface - - - Unimproved road - - -
() Interstate Route { } U. S. Route () State Route

MATHEWS CORNER, WASH.

NW 1/4 ELTOPIA 15' QUADRANGLE
N4622.5—W11907.5/7.5

1975

AMS 2176 | NW -SERIES V801

2
36122

REFERENCE 18

Memo to file from DA Lamar, on 8-18-87, regarding Personal
Observations of Columbia River Intakes at Taylor Flats
----- and Ringold Flats

Date August 18, 1987
To File
From D. A. Lamar
Subject Personal Observations of Columbia River Intakes at
Taylor Flats and Ringold

In observation of the Columbia River, 3 intakes were found in the Taylor Flats region serving as irrigation for crops and forage. In the Ringold Ranch area there are 2 intakes that serve the region as irrigation for crops and forage. At the Ringold Hatchery there was observed one intake that serves for the rearing of steelhead fingerlings.

DAL:dar

REFERENCE 19

Endangered and Threatened Wildlife and Plants, 50 CFR,
Part 17, Subpart B, October 86

94320-0001
107-028-16

§ 17.11

issued under Part 21 of this chapter, and

(2) Identified in the earliest applicable annual report required to be filed by a permittee under Part 21 of this chapter as in a permittee's possession on November 10, 1978, or as the progeny of such a raptor.

(b) This section does not apply to any raptor intentionally returned to the wild.

[48 FR 31807, July 8, 1983]

Subpart B—Lists

SOURCE: 48 FR 34182, July 27, 1983, unless otherwise noted.

§ 17.11 Endangered and threatened wildlife.

(a) The list in this section contains the names of all species of wildlife which have been determined by the Services to be Endangered or Threatened. It also contains the names of species of wildlife treated as Endangered or Threatened because they are sufficiently similar in appearance to Endangered or Threatened species (see § 17.50 *et seq.*).

(b) The columns entitled "Common Name," "Scientific Name," and "Vertebrate Population Where Endangered or Threatened" define the species of wildlife within the meaning of the Act. Thus, differently classified geographic populations of the same vertebrate subspecies or species shall be identified by their differing geographic boundaries, even though the other two columns are identical. The term "Entire" means that all populations throughout the present range of a vertebrate species are listed. Although common names are included, they cannot be relied upon for identification of any specimen, since they may vary greatly in local usage. The Services shall use the most recently accepted scientific name. In cases in which confusion might arise, a synonym(s) will be provided in parentheses. The Services shall rely to the extent practicable on the *International Code of Zoological Nomenclature*.

(c) In the "Status" column the following symbols are used: "E" for Endangered, "T" for Threatened, and "E

50 CFR Ch. I (10-1-86 Edition)

[or T] (S/A)" for similarity of appearance species.

(d) The other data in the list are nonregulatory in nature and are provided for the information of the reader. In the annual revision and compilation of this title, the following information may be amended without public notice: the spelling of species' names, historical range, footnotes, references to certain other applicable portions of this title, synonymy, and more current names. In any of these revised entries, neither the species, as defined in paragraph (b) of this section, nor its status may be changed without following the procedures of Part 424 of this title.

(e) The "historic range" indicates the known general distribution of the species or subspecies as reported in the current scientific literature. The present distribution may be greatly reduced from this historic range. This column does not imply any limitation on the application of the prohibitions in the Act or implementing rules. Such prohibitions apply to all individuals of the species, wherever found.

(f)(1) A footnote to the *FEDERAL REGISTER* publication(s) listing or reclassifying a species is indicated under the column "When Listed." Footnote numbers to §§ 17.11 and 17.12 are in the same numerical sequence, since plants and animals may be listed in the same *FEDERAL REGISTER* document. That document, at least since 1973, includes a statement indicating the basis for the listing, as well as the effective date(s) of said listing.

(2) The "Special rules" and "Critical habitat" columns provide a cross reference to other sections in Parts 17, 222, 226, or 227. The "Special rules" column will also be used to cite the special rules that describe experimental populations and determine if they are essential or nonessential. Separate listing will be made for experimental populations, and the status column will include the following symbols: "XE" for an essential experimental population and "XN" for a nonessential experimental population. The term "NA" (not applicable) appearing in either of these two columns indicates that there are no special rules and/or critical habitat for that par-

U.S. Fish and

Wildlife Service
particular species
appropriate n
through 227
that species.
other rules i
such wildlife
quirements. I
references i
column list a
two Services
species or to
Federal agen
ernments.

(g) The list includes all lo
example, the
bons) is listed

particular species. However, all other appropriate rules in Parts 17, 217 through 227, and 402 still apply to that species. In addition, there may be other rules in this title that relate to such wildlife, e.g., port-of-entry requirements. It is not intended that the references in the "Special rules" column list all the regulations of the two Services which might apply to the species or to the regulations of other Federal agencies or State or local governments.

(g) The listing of a particular taxon includes all lower taxonomic units. For example, the genus *Hyllobates* (gibbons) is listed as Endangered through-

out its entire range (China, India, and SE Asia); consequently, all species, subspecies, and populations of that genus are considered listed as Endangered for the purposes of the Act. In 1978 (43 FR 6230-6233) the species *Haliaeetus leucocephalus* (bald eagle) was listed as Threatened in "USA (WA, OR, MN, WI, MI)" rather than its entire population; thus, all individuals of the bald eagle found in those five States are considered listed as Threatened for the purposes of the Act.

(h) The "List of Endangered and Threatened Wildlife" is provided below:

Species		Historic range	Vertebrate population where endangered or threatened	Sta- tus	When listed	Critical habitat	Special rules
Common name	Scientific name						
MAMMALS							
Anoa, lowland	<i>Bubalus depressicornis</i> (= <i>B. anoa depressicornis</i>)	Indonesia	Entire	E	3	NA	NA
Anoa, mountain	<i>Bubalus quarexi</i> (= <i>B. anoa quarexi</i>)	do	do	E	15	NA	NA
Antelope, giant sable	<i>Hippotragus niger varians</i>	Angola	do	E	15	NA	NA
Argali	<i>Ovis ammon hodgsoni</i>	China (Tibet, Himalayas)	do	E	15	NA	NA
Armadillo, giant	<i>Prodonates maximus</i> (= <i>giganteus</i>)	Venezuela and Guyana to Argentina	do	E	15	NA	NA
Armadillo, pink fairy	<i>Chlamyphorus truncatus</i>	Argentina	do	E	3	NA	NA
Ass, African wild	<i>Equus asinus</i> (= <i>africanus</i>)	Somalia, Sudan, Ethiopia	Somalia, Sudan, Ethiopia	E	3, 22	NA	NA
Ass, Asian wild (= Indian, onager)	<i>Equus hemionus</i>	Southwestern and Central Asia	Entire	E	3	NA	NA
Avahi	<i>Avahi</i> (= <i>Lichenotus</i>) <i>laniger</i> (= entire genus)	Madagascar Republic (= Madagascar)	do	E	3	NA	NA
Aye-Aye	<i>Daubentonius madagascariensis</i>	Madagascar Republic (= Madagascar)	do	E	3	NA	NA
Babirusa	<i>Babirusa babirusa</i>	Indonesia	do	E	15	NA	NA
Baboon, gelada	<i>Theropithecus gelada</i>	Ethiopia	do	E	15	NA	NA
Bandicoot, barred	<i>Perameles bougainville</i>	Australia	do	E	4	NA	17.40(c)
Bandicoot, desert	<i>Perameles eromanga</i>	do	do	E	4	NA	NA
Bandicoot, lesser rabbit	<i>Macrotis leucura</i>	do	do	E	4	NA	NA
Bandicoot, pig-footed	<i>Chaeropus ecaudatus</i>	do	do	E	4	NA	NA
Bandicoot, rabbit	<i>Macrotis lagotis</i>	do	do	E	4	NA	NA
Banteng	<i>Bos javanicus</i> (= <i>banteng</i>)	Southeast Asia	do	E	4	NA	NA
Bat, Blümer's fruit (flying fox)	<i>Aproteles blumeri</i>	Papua New Guinea	do	E	3	NA	NA
Bat, bumblebee	<i>Craseonycteris thonglongyai</i>	Thailand	do	E	130	NA	NA
Bat, gray	<i>Myotis grisescens</i>	Central and Southeastern U.S.A.	do	E	130	NA	NA
Bat, Hawaiian hoary	<i>Lasiurus cinereus semotis</i>	U.S.A. (HI)	do	E	13	NA	NA
Bat, Indiana	<i>Myotis sodalis</i>	Eastern and Midwestern U.S.A.	do	E	2	NA	NA
Bat, little Mariana fruit	<i>Pteropus tokudae</i>	Western Pacific Ocean: U.S.A. (Guam)	do	E	1	17.95(a)	NA
Bat, Mariana fruit	<i>Pteropus mariannus mariannus</i>	Western Pacific Ocean: U.S.A. (Guam, Rota, Tinian, Saipan, Agiguan)	Guam	E	150	NA	NA
Bat, Ozark big-eared	<i>Plecotus townsendi ingens</i>	U.S.A. (MO, OK, AR)	Entire	E	85	NA	NA
Bat, Rodrigues fruit (flying fox)	<i>Pteropus rodriguesi</i>	Indian Ocean: Rodrigues Island	do	E	130	NA	NA
Bat, Singapore roundleaf horseshoe	<i>Hipposideros rufus</i>	Malaysia	do	E	130	NA	NA
Bat, Virginia big-eared	<i>Plecotus townsendi virginianus</i>	U.S.A. (KY, NC, WV, VA)	do	E	85	17.95(a)	NA
Bear, black	<i>Ursus thibetanus gedrolensis</i>	Iran, Pakistan	do	E	233	NA	NA
Bear, brown	<i>Ursus arctos pinnatus</i>	China (Tibet)	Guam	E	15	NA	NA
Bear, brown	<i>Ursus arctos arctos</i>	Paleartic	Italy	E	15	NA	NA
Bear, brown or grizzly	<i>Ursus arctos</i> (= <i>U. harrisi</i>)	Holarctic	U.S.A. 48	E	1, 2, 3	NA	NA
Bear, brown or grizzly	<i>Ursus arctos</i> (= <i>U. nelsoni</i>)	Holarctic	Alaska	E	3	NA	NA
Beaver	<i>Castor fiber bairdii</i>	Mongolia	Mexico	E	15	NA	NA
Bison, wood	<i>Bison bison athabascus</i>	Canada, Northwestern U.S.A.	Canada	E	3	NA	NA

\$ 17.11

50 CFR Ch. I (10-1-86 Edition)

Bobcat	<i>Felis rufus esculapae</i>	Central Mexico	Entire	E	15	NA	NA
Bontebok (antelope)	<i>Damaliscus dorcas dorcas</i>	South Africa	do	E	15	NA	NA
Camel, bactrian	<i>Camelus bactrianus</i> (= <i>ferus</i>)	Mongolia, China	do	E	15	NA	NA
Caribou, woodland	<i>Rangifer tarandus caribou</i>	Canada, U.S.A. (AK, ID, ME, MI, MN, MT, NH, VT, WA, WI)	Canada (that part of S.E. Brit. Col. bounded by the Can.-USA border, Columbia R.,	E	120E, 130E, 143	NA	NA

U.S. Fish and

Bobcat	<i>Felis rufus escuinape</i>	Central Mexico	Entire	E	15	NA	NA
Bontebok (antelope)	<i>Damaeacus dorcas dorcas</i>	South Africa	do	E	15	NA	NA
Camel, Bactrian	<i>Camelus bactrianus</i> (= ferus)	Mongolia, China	do	E	15	NA	NA
Caribou, woodland	<i>Rangifer tarandus caribou</i>	Canada, U.S.A. (AK, ID, ME, MI, MN, MT, NH, VT, WA, WI)	Canada (that part of S.E. Brit. Col. bounded by the Can.-USA border, Columbia R., Kootenay R., Kootenay L., and Kootenay R.), U.S.A. (ID, WA)	E	128E, 136E, 143	NA	NA
Cat, Andean	<i>Felis jacobita</i>	Chile, Peru, Bolivia, Argentina	Entire	E	15	NA	NA
Cat, black-footed	<i>Felis nigripes</i>	Southern Africa	do	E	15	NA	NA
Cat, Bat-headed	<i>Felis planiceps</i>	Malaysia, Indonesia	do	E	15	NA	NA
Cat, Miomote	<i>Felis (Mayskuna) miomotensis</i>	Japan (Miomote Island, Ryukyu Islands)	do	E	50	NA	NA
Cat, leopard	<i>Felis bengalensis bengalensis</i>	India, Southeast Asia	do	E	15	NA	NA
Cat, marbled	<i>Felis marmorata</i>	Nepal, Southeast Asia, Indonesia	do	E	15	NA	NA
Cat, Pakistan sand	<i>Felis margarita schellii</i>	Pakistan	do	E	138	NA	NA
Cat, Temminck's (= golden cat)	<i>Felis temminckii</i>	Nepal, China, Southeast Asia, Indonesia (Sumatra)	do	E	15	NA	NA
Cat, tiger	<i>Felis tigris</i>	Costa Rica to northern Argentina	do	E	5	NA	NA
Chamois, Apennine	<i>Rupicapra rupicapra ornata</i>	Italy	do	E	15	NA	NA
Cheetah	<i>Achoryx jubatus</i>	Africa to India	do	E	3, 5	NA	NA
Chimpanzee	<i>Pan troglodytes</i>	West and Central Africa	do	T	16	NA	17.40(c)
Chimpanzee, pygmy	<i>Pan paniscus</i>	Zaire	do	T	16	NA	17.40(c)
Chinchilla	<i>Chinchilla brevicaudata boliviana</i>	Bolivia	do	E	15	NA	NA
Civet, Malabar large-spotted	<i>Viverra megaspila civetina</i>	India	do	E	50	NA	NA
Cochito (= Gulf of California harbor porpoise)	<i>Phocoena sinu</i>	Mexico (Gulf of California)	do	E	166	NA	NA
Colobus, Preuss's red	<i>Colobus badius preussi</i>	Cameroon	do	E	138	NA	NA
Cougar, eastern	<i>Felis concolor cougar</i>	Eastern North America	do	E	5	NA	NA
Deer, Bactrian	<i>Cervus elaphus bactrianus</i>	U.S.S.R., Afghanistan	do	E	50	NA	NA
Deer, Bawean	<i>Audu (= Cervus) porcinus kuhli</i>	Indonesia	do	E	3	NA	NA
Deer, Barbary	<i>Cervus elaphus barbarus</i>	Morocco, Tunisia, Algeria	do	E	50	NA	NA
Deer, Cedros Island mule	<i>Odocoileus hemionus cedrosensis</i>	Mexico (Cedros Island)	do	E	10	NA	NA
Deer, Columbian white-tailed	<i>Odocoileus virginianus leucurus</i>	U.S.A. (WA, OR)	do	E	1	NA	NA
Deer, Corsican red	<i>Cervus elaphus corsicanus</i>	Corsica, Sardinia	do	E	50	NA	NA
Deer, Eld's brow-antlered	<i>Cervus eldi</i>	India to Southeast Asia	do	E	3	NA	NA
Deer, Formosan sika	<i>Cervus nippon taiouanus</i>	Taiwan	do	E	50	NA	NA
Deer, hog	<i>Audu (= Cervus) porcinus annamiticus</i>	Thailand, Indochina	do	E	15	NA	NA
Deer, key	<i>Odocoileus virginianus clavium</i>	U.S.A. (FL)	do	E	1	NA	NA
Deer, marsh	<i>Blastocerus dichotomus</i>	Argentina, Uruguay, Paraguay, Bolivia, Brazil	do	E	3	NA	NA
Deer, McNeill's	<i>Cervus elaphus mcneilli</i>	China (Sinkiang, Tibet)	do	E	3	NA	NA

U.S. Fish and Wildlife Serv., Interior

§ 17.11

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Deer, musk	<i>Moschus</i> spp. (all species)	Central and East Asia	Afghanistan, Bhutan, Burma, China (Tibet, Yunnan), India, Nepal, Pakistan, Sikkim.	E	15	NA	NA
Deer, North China aka	<i>Cervus nippon mandchuricus</i>	China (Shantung and Chihli Provinces)	Entire	E	50	NA	NA
Deer, pampas	<i>Ozotoceros bezoaricus</i>	Brazil, Argentina, Uruguay, Bolivia, Paraguay.	do	E	15	NA	NA
Deer, Persian fallow	<i>Dama dama mesopotamica</i>	Iraq, Iran	do	E	3	NA	NA
Deer, Philippine	<i>Axis (=Cervus) porcinus calamianensis</i>	Philippines (Calamian Islands)	do	E	15	NA	NA
Deer, Ryukyu aka	<i>Cervus nippon keramae</i>	Japan (Ryukyu Islands)	do	E	50	NA	NA
Deer, Shanai aka	<i>Cervus nippon grassianus</i>	China (Shanai Province)	do	E	50	NA	NA
Deer, South China aka	<i>Cervus nippon kopschi</i>	Southern China	do	E	50	NA	NA
Deer, swamp (= barasingha)	<i>Cervus duvauceli</i>	India, Nepal	do	E	3	NA	NA
Deer, Yarkand	<i>Cervus elaphus yarkandensis</i>	China (Sinkiang)	do	E	50	NA	NA
Dhole (= Asiatic wild dog)	<i>Canis alpinus</i>	U.S.S.R., Korea, China, India, Southeast Asia	do	E	3	NA	NA
Dibbler	<i>Antechinus apicalis</i>	Australia	do	E	4	NA	NA
Dog, African wild	<i>Lycan pictus</i>	Sub-Saharan Africa	do	E	138	NA	NA
Drill	<i>Papio leucophaeus</i>	Equatorial West Africa	do	E	16	NA	NA
Dugong	<i>Dugong dugon</i>	East Africa to southern Japan, including U.S.A. (Trust Territories)	do	E	4	NA	NA
Duker, Jentink's	<i>Cephalophus jentinki</i>	Sierra Leone, Liberia, Ivory Coast	do	E	50	NA	NA
Eland, Western giant	<i>Taurotragus derbianus derbianus</i>	Senegal to Ivory Coast	do	E	50	NA	NA
Elephant, African	<i>Loxodonta africana</i>	Africa	do	E	40	NA	17.40(a)
Elephant, Asian	<i>Elephas maximus</i>	South-central and Southeast Asia	do	E	16	NA	NA
Ferret, black-footed	<i>Mustela nigripes</i>	Western U.S.A., Western Canada	do	E	1, 3	NA	NA
Fox, Northern swift	<i>Vulpes velox hesperis</i>	U.S.A. (northern plains), Canada	Canada	E	3	NA	NA
Fox, San Joaquin hill	<i>Vulpes macrotis mutica</i>	U.S.A. (CA)	Entire	E	1	NA	NA
Fox, Simien	<i>Canis (Simenia) simensis</i>	Ethiopia	do	E	50	NA	NA
Gazelle, Clark's (= Dibetagi)	<i>Ammodorcas clarkei</i>	Somalia, Ethiopia	do	E	3	NA	NA
Gazelle, Cuvier's	<i>Gazelle cuvieri</i>	Morocco, Algeria, Tunisia	do	E	3	NA	NA
Gazelle, Mhor	<i>Gazelle dama mhor</i>	Morocco	do	E	3	NA	NA
Gazelle, Moroccan (= Dorcas)	<i>Gazelle dorcas massaesyli</i>	Morocco, Algeria, Tunisia	do	E	3	NA	NA
Gazelle, Rio de Oro Dama	<i>Gazelle dama iozanol</i>	Western Sahara	do	E	3	NA	NA
Gazelle, Arabian	<i>Gazelle gazella</i>	Arabian Peninsula, Palestine, Sinai	do	E	50	NA	NA
Gazelle, sand	<i>Gazelle subgutturosa marica</i>	Jordan, Arabian Peninsula	do	E	50	NA	NA
Gazelle, Saudi Arabian	<i>Gazelle dorcas saudiya</i>	Israel, Iraq, Jordan, Syria, Arabian Peninsula	do	E	50	NA	NA
Gazelle, Pelzeln's	<i>Gazelle dorcas pelzelni</i>	Somalia	do	E	50	NA	NA
Gazelle, slender-horned (= Phipps)	<i>Gazelle leptoceros</i>	Sudan, Egypt, Algeria, Libya	do	E	3	NA	NA
Gibbons	<i>Hylodactylus</i> spp. (including <i>Nomascus</i>)	China, India, Southeast Asia	do	E	3, 15	NA	NA

§ 17.11

50 CFR Ch. I (10-1-86 Edition)

Goat, wild (= Chitani markhor)	<i>Capra sibirica (= isiconis chitaniensis)</i>	Southwestern Asia	Chitani Range of west-central Pakistan.	E	15	NA	NA	U.S. 1
Goral	<i>Nemorhaedus goral</i>	East Asia	Entire	E	15	NA	NA	
Gorilla	<i>Gorilla</i>			E	15	NA	NA	

Goat, wild (=Chilian markhor)	<i>Capra aegagrus (=taxonoid chilianensis)</i>	Southwestern Asia	Chilian Range of west-central Pakistan	E	15	NA	NA
Goral	<i>Nemorhaedus goral</i>	East Asia	Entire	E	15	NA	NA
Gorilla	<i>Gorilla gorilla</i>	Central and Western Africa	do	E	3	NA	NA
Guadalupe fur seal	<i>Arctocephalus townsendi</i>	U.S.A. (Farallon Islands of CA) south to Mexico (Isla Revillagigedo)	do	T	212	NA	227.11
Hare, Nepali	<i>Caprolagus nupur</i>	India, Nepal, Bhutan	do	E	15	NA	NA
Hartebeest, Swazyme's	<i>Alcelaphus buselaphus swazyme</i>	Ethiopia, Somalia	do	E	3, 50	NA	NA
Hartebeest, Tora	<i>Alcelaphus buselaphus tora</i>	Ethiopia, Sudan, Egypt	do	E	50	NA	NA
Hog, pygmy	<i>Sus salvanius</i>	India, Nepal, Bhutan, Sikkim	do	E	3	NA	NA
Horse, Przewalski's	<i>Equus przewalskii</i>	Mongolia, China	do	E	15	NA	NA
Huemul, North Andean	<i>Hippocamelus antisensis</i>	Ecuador, Peru, Chile, Bolivia, Argentina	do	E	15	NA	NA
Huemul, South Andean	<i>Hippocamelus basilus</i>	Chile, Argentina	do	E	15	NA	NA
Hula, Cabrera's	<i>Capromys angelcabrerai</i>	Cuba	do	E	233	NA	NA
Hula, dwarf	<i>Capromys nana</i>	do	do	E	233	NA	NA
Hula, large-eared	<i>Capromys auritus</i>	do	do	E	233	NA	NA
Hula, little-eared	<i>Capromys santaliparais</i>	do	do	E	233	NA	NA
Hyena, Barbary	<i>Hyena hyena barbara</i>	Morocco, Algeria, Tunisia	do	E	3	NA	NA
Hyena, brown	<i>Hyena brunnea</i>	Southern Africa	do	E	3	NA	NA
Ibex, Pyrenean	<i>Capra pyrenaica pyrenaica</i>	Spain	do	E	3	NA	NA
Ibex, Walla	<i>Capra walla</i>	Ethiopia	do	E	3	NA	NA
Impala, black-faced	<i>Aepyceros melampus petersi</i>	Namibia, Angola	do	E	3	NA	NA
Indri	<i>Indri indri (=entire genus)</i>	Madagascar	do	E	3	NA	NA
Jaguar	<i>Panthera onca</i>	U.S.A. (TX, NM, AZ), C. and S. America	Mexico southward	E	8	NA	NA
Jaguarundi	<i>Felis jagouaroundi cacomili</i>	U.S.A. (TX), Mexico	Entire	E	15	NA	NA
Jaguarundi	<i>Felis jagouaroundi fossata</i>	Mexico, Nicaragua	do	E	15	NA	NA
Jaguarundi	<i>Felis jagouaroundi panamensis</i>	Nicaragua, Costa Rica, Panama	do	E	15	NA	NA
Jaguarundi	<i>Felis jagouaroundi tollaci</i>	U.S.A. (AZ), Mexico	do	E	15	NA	NA
Kangaroo, eastern gray	<i>Macropus giganteus</i> (all subspecies except tasmanianensis)	Australia	do	T	7	NA	17.40(a)
Kangaroo, red	<i>Macropus (Megaleia) rufus</i>	do	do	T	7	NA	17.40(a)
Kangaroo, Tasmanian forest	<i>Macropus giganteus tasmanianensis</i>	Australia (Tasmania)	do	E	8	NA	NA
Kangaroo, western gray	<i>Macropus fuliginosus</i>	Australia	do	T	7	NA	17.40(a)
Kouprey	<i>Bos sauveli</i>	Vietnam, Laos, Cambodia, Thailand	do	E	3	NA	NA
Langur, capped	<i>Presbytis pileata</i>	India, Burma, Bangladesh	do	E	15	NA	NA
Langur, entellus	<i>Presbytis entellus</i>	China (Tibet), India, Pakistan, Kashmir, Sri Lanka, Sikkim, Bangladesh	do	E	15	NA	NA
Langur, Douc	<i>Pygathrix nemaeus</i>	Cambodia, Laos, Vietnam	do	E	3	NA	NA
Langur, Francois	<i>Presbytis francoisi</i>	China (Kwangai), Indochina	do	E	15	NA	NA
Langur, golden	<i>Presbytis goldi</i>	India (Assam), Bhutan	do	E	15	NA	NA
Langur, long-tailed	<i>Presbytis potenziani</i>	do	do	T	15	NA	17.40(c)
Langur, Pag Island	<i>Nasalis (Simia) concolor</i>	do	do	E	3	NA	NA
Langur, purple-faced	<i>Presbytis senex</i>	Sri Lanka (=Ceylon)	do	T	15	NA	17.40(c)
Langur, Tonkin snub-nosed	<i>Pygathrix (Rhinopithecus) avunculus</i>	Vietnam	do	T	15	NA	17.40(c)
Lechwe, red	<i>Kobus lechwe</i>	Southern Africa	do	T	3, 15, 108	NA	NA

78

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Lemurs	Lemuridae (incl. Cheirogaleidae, Lepiduridae); all members of genera <i>Lemur</i> , <i>Phaner</i> , <i>Haplorhina</i> , <i>Lepidur</i> , <i>Microcebus</i> , <i>Allocebus</i> , <i>Cheirogaleus</i> , <i>Varecia</i> .	Malagasy Republic (= Madagascar)	do	E	3, 15	NA	NA
Leopard	<i>Panthera pardus</i>	Africa, Asia	Wherever found, except where it is listed as Threatened as set forth below.	E	3, 5, 114	NA	NA
Do	do	do	In Africa, in the wild, south of, and including, the following countries: Gabon, Congo, Zaire, Uganda, Kenya.	T	3, 5, 114	NA	17.40(f)
Leopard, clouded	<i>Neofelis nebulosa</i>	Southeast and south-central Asia, Taiwan	Entire	E	3, 15	NA	NA
Leopard, snow	<i>Panthera uncia</i>	Central Asia	do	E	5	NA	NA
Linang, spotted	<i>Prionodon pardicolor</i>	Nepal, Assam, Vietnam, Cambodia, Laos, Burma	do	E	15	NA	NA
Lion, Asiatic	<i>Panthera leo persica</i>	Turkey to India	do	E	3	NA	NA
Loris, lesser slow	<i>Myotis pygmaeus</i>	Indochina	do	E	10	NA	17.40(c)
Lynx, Spanish	<i>Felis (= Lynx) pardina</i>	Spain, Portugal	do	E	3	NA	NA
Macaque, Formosan rock	<i>Macaca cyclops</i>	Taiwan	do	T	10	NA	17.40(c)
Macaque, Japanese	<i>Macaca fuscata</i>	Japan (Shikoku, Kyushu and Honshu islands)	do	T	10	NA	17.40(c)
Macaque, lion-tailed	<i>Macaca silenus</i>	India	do	E	3	NA	NA
Macaque, stump-tailed	<i>Macaca arctoides</i>	India (Assam) to southern China	do	T	10	NA	17.40(c)
Macaque, toque	<i>Macaca sinica</i>	Sri Lanka (= Ceylon)	do	E	10	NA	17.40(c)
Manatee, Amazonian	<i>Trichechus inunguis</i>	South America (Amazon River Basin)	do	T	3	NA	NA
Manatee, West African	<i>Trichechus senegalensis</i>	West Coast of Africa from Senegal River to Cuanza River	do	T	52	NA	NA
Manatee, West Indian (Florida)	<i>Trichechus manatus</i>	U.S.A. (southeastern), Caribbean Sea, South America	do	E	1, 3	17.05(a)	NA
Mandrill	<i>Papio sphinx</i>	Equatorial West Africa	do	E	10	NA	NA
Mangabey, Tana River	<i>Cercocebus galerita</i>	Kenya	do	E	3	NA	NA
Mangabey, white-collared	<i>Cercocebus torquatus</i>	Senegal to Ghana; Nigeria to Gabon	do	E	10	NA	NA
Marigay	<i>Felis wiedii</i>	U.S.A. (TX), C and S. America	Mexico southward	E	6	NA	NA
Markhor, Kابل	<i>Capra falconeri megaceros</i>	Afghanistan, Pakistan	do	E	15	NA	NA
Markhor, straight-horned	<i>Capra falconeri jerdoni</i>	do	do	E	15	NA	NA
Marmoset, bull-headed	<i>Callicebus flaviceps</i>	Brazil	do	E	130	NA	NA

§ 17.11

50 CFR Ch. I (10-1-86 Edition)

Marmoset, buffy-tailed ear	<i>Callicebus jacchus aurita</i>	do	do	E	233	NA	NA
Marmoset, cotton-top	<i>Saguinus oedipus</i>	Costa Rica to Colombia	do	E	10	NA	NA
Marmoset, Goeldi's	<i>Callimico goeldii</i>	Brazil, Colombia, Ecuador, Peru, Bolivia	do	E	3	NA	NA
Marmot, Vancouver Island	<i>Marmota vancouveriensis</i>	Canada (Vancouver Island)	do	E	130	NA	NA
Marsupial, eastern jerboa	<i>Antechinus laniger</i>	Australia	do	E	4	NA	NA
Marsupial-mouse, large desert	<i>Smithopsis psammophila</i>	do	do	E	4	NA	NA
Marsupial-mouse, long-tailed	<i>Smithopsis longicauda</i>	do	do	E	4	NA	NA

U.S. Fish

Markhor, Kabei	<i>Capra falconeri megaloceros</i>	Algeria	18	NA	NA
Markhor, straight-horned	<i>Capra falconeri jerdoni</i>	do	18	NA	NA
Marmoset, buff-headed	<i>Callithrix jacchus</i>	Brazil	139	NA	NA

Marmoset, buff tufted-ear	<i>Callithrix jacchus surilis</i>	do	do		
Marmoset, cotton-top	<i>Saguinus oedipus</i>	Costa Rica to Colombia	do		
Marmoset, Gould's	<i>Callimico goeldii</i>	Brazil, Colombia, Ecuador, Peru, Bolivia	do		
Marmot, Vancouver Island	<i>Marmota vancouverensis</i>	Canada (Vancouver Island)	do		
Marsupial, eastern jerboa	<i>Antechinus leniger</i>	Australia	do		
Marsupial-mouse, large desert	<i>Sminthopsis psammophila</i>	do	do		
Marsupial-mouse, long-tailed	<i>Sminthopsis longicauda</i>	do	do		
Marian, Formosan yellow-throated	<i>Meris flavigula chrysops</i>	Taiwan	do		
Monkey, black colobus	<i>Colobus satanas</i>	Equatorial Guinea, People's Republic of Congo, Cameroon, Gabon	do		
Monkey, black howler	<i>Alouatta pigra</i>	Mexico, Guatemala, Belize	do		
Monkey, Diana	<i>Cercopithecus dians</i>	Coastal West Africa	do		
Monkey, howler	<i>Alouatta palliata (= villosa)</i>	Mexico to South America	do		
Monkey, L'hoest's	<i>Cercopithecus thomasi</i>	Upper Eastern Congo Basin, Cameroon	do		
Monkey, Prause's red colobus	<i>Colobus badius praussi</i>	Cameroon	do		
Monkey, proboscis	<i>Nasalis larvatus</i>	Borneo	do		
Monkey, red-backed squirrel	<i>Saimiri oerstedii</i>	Costa Rica, Panama	do		
Monkey, red bellied	<i>Cercopithecus erythrogaster</i>	Western Nigeria	do		
Monkey, red-eared nose-spotted	<i>Cercopithecus erythrolis</i>	Nigeria, Cameroon, Fernando Po	do		
Monkey, spider	<i>Ateles geoffroyi frontatus</i>	Costa Rica, Nicaragua	do		
Monkey, spider	<i>Ateles geoffroyi panamensis</i>	Costa Rica, Panama	do		
Monkey, Tana River red colobus	<i>Colobus rufonigratus (= badius) rufonigratus</i>	Kenya	do		
Monkey, woolly spider	<i>Brachyteles arachnoides</i>	Brazil	do		
Monkey, yellow-tailed woolly	<i>Lagothrix flavicauda</i>	Andes of northern Peru	do		
Monkey, Zanzibar red colobus	<i>Colobus kirkii</i>	Tanzania	do		
Mouse, Alabama beach	<i>Peromyscus polionotus ammohabes</i>	U.S.A. (AL)	do		
Mouse, Australian native	<i>Zyomys (= Notomys) pedunculatus</i>	Australia	do		
Mouse, Australian native	<i>Notomys squillo</i>	do	do		
Mouse, Choctawhatchee beach	<i>Peromyscus polionotus aliphys</i>	U.S.A. (FL)	do		
Mouse, Field's	<i>Pseudomys fieldi</i>	Australia	do		
Mouse, Gould's	<i>Pseudomys gouldii</i>	do	do		
Mouse, Key Largo cotton	<i>Peromyscus gossypinus atlapetole</i>	U.S.A. (FL)	do		
Mouse, New Holland	<i>Pseudomys novaehollandiae</i>	Australia	do		
Mouse, Perdo Key beach	<i>Peromyscus polionotus trisyllipale</i>	U.S.A. (AL, FL)	do		
Mouse, salt marsh harvest	<i>Rethrodontomys raviventris</i>	U.S.A. (CA)	do		
Mouse, Shark Bay	<i>Pseudomys praecox</i>	Australia	do		
Mouse, Shortridge's	<i>Pseudomys shortridgei</i>	do	do		
Mouse, Smoky	<i>Pseudomys furvus</i>	do	do		
Mouse, western	<i>Pseudomys occidentalis</i>	do	do		
Muntjac, Fee's	<i>Muntiacus leae</i>	Northern Thailand, Burma	do		
Native-cat, eastern	<i>Dasyurus viverrinus</i>	Australia	do		
Numbat	<i>Myrmecobius fasciatus</i>	do	do		
Ocelot	<i>Felis pardalis</i>	U.S.A. (AZ, TX) to C. and S. America	do		
Orangutan	<i>Pongo pygmaeus</i>	Borneo, Sumatra	do		
Oryx, Arabian	<i>Oryx leucoryx</i>	Arabian Peninsula	do		
Otter, Cameroon clawless	<i>Aonyx (= Paronyx) congica microdon</i>	Cameroon, Nigeria	do		

E	233	NA	NA	U.S. Fish and Wildlife Serv., Interior
E	18	NA	NA	
E	3	NA	NA	
E	139	NA	NA	
E	4	NA	NA	
E	4	NA	NA	
E	4	NA	NA	
E	3	NA	NA	
E	18	NA	NA	
T	18	NA	17.40(c)	
E	18	NA	NA	
E	18	NA	NA	
E	18	NA	NA	
E	139	NA	NA	
E	15	NA	NA	
E	3	NA	NA	
E	18	NA	NA	
E	18	NA	NA	
E	3	NA	NA	
E	3	NA	NA	
E	3, 18	NA	NA	
E	3	NA	NA	
E	18	NA	NA	
E	3	NA	NA	
E	183	17.90(a)	NA	
E	15	NA	NA	
E	15	NA	NA	
E	183	17.95(a)	NA	
E	4	NA	NA	
E	6	NA	NA	
E	131E	NA	NA	
E	160			
E	4	NA	NA	
E	183	17.95(a)	NA	
E	2	NA	NA	
E	4	NA	NA	
E	4	NA	NA	
E	4	NA	NA	
E	4	NA	NA	
E	50	NA	NA	
E	6	NA	NA	
E	4, 6	NA	NA	
E	5, 118	NA	NA	
E	3	NA	NA	
E	3	NA	NA	
E	3	NA	NA	

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Otter, giant	<i>Pteronura brasiliensis</i>	South America	do.	E	3	NA	NA
Otter, long-tailed	<i>Lutra longicaudus</i> (incl. <i>platensis</i>)	do.	do.	E	3, 15	NA	NA
Otter, marine	<i>Lutra lutra</i>	Peru south to Straits of Magellan	do.	E	15	NA	NA
Otter, southern river	<i>Lutra provocax</i>	Chile, Argentina	do.	E	15	NA	NA
Otter, southern sea	<i>Enhydra lutris nereis</i>	West coast U.S.A. (WA, OR, CA) south to Mexico (Baja California)	do.	E	21	NA	NA
Panda, giant	<i>Ailuropus melanoleucus</i>	People's Republic of China	do.	E	130	NA	NA
Pangolin (= scaly anteater)	<i>Manis temminckii</i>	Africa	do.	E	15	NA	NA
Panther, Florida	<i>Felis concolor coryi</i>	U.S.A. (LA and AR east to SC and FL)	do.	E	1	NA	NA
Planigale, little	<i>Planigale ingrami subblissima</i> (formerly <i>P. subblissima</i>)	Australia	do.	E	4	NA	NA
Planigale, southern	<i>Planigale tenuirostris</i>	do.	do.	E	4	NA	NA
Porcupine, thin-spined	<i>Chaetomys subspinosus</i>	Brazil	do.	E	4	NA	NA
Possum, Leadbeater's	<i>Gymnobelideus leadbeateri</i>	do.	do.	E	3	NA	NA
Possum, mountain pygmy	<i>Burramys parvus</i>	Australia	do.	E	233	NA	NA
Possum, scaly-tailed	<i>Woytkia squameicaudata</i>	do.	do.	E	4	NA	NA
Prairie dog, Mexican	<i>Cynomys mexicanus</i>	Mexico	do.	E	4	NA	NA
Prairie dog, Utah	<i>Cynomys parvidens</i>	U.S.A. (UT)	do.	E	3	NA	NA
Pronghorn, peninsular	<i>Antilocapra americana peninsularis</i>	Mexico (Baja California)	do.	E	6, 140	NA	17.40(g)
Pronghorn, Sonoran	<i>Antilocapra americana sonoriensis</i>	U.S.A. (AZ), Mexico	do.	E	10	NA	NA
Pudu	<i>Pudu pudu</i>	Southern South America	do.	E	1, 3	NA	NA
Puma, Costa Rican	<i>Felis concolor costaricensis</i>	Nicaragua, Panama, Costa Rica	do.	E	15	NA	NA
Quokka	<i>Setonix brachyurus</i>	Australia	do.	E	15	NA	NA
Rabbit, Ryukyu	<i>Pentalagus furnessi</i>	Japan (Ryukyu Islands)	do.	E	6	NA	NA
Rabbit, volcano	<i>Romerolagus diazi</i>	Mexico	do.	E	50	NA	NA
Rat, false water	<i>Xeromys myoides</i>	Australia	do.	E	3	NA	NA
Rat, Fresno kangaroo	<i>Dipodomys nitratoides exilis</i>	U.S.A. (CA)	do.	E	4	NA	NA
Rat, Moro Bay kangaroo	<i>Dipodomys heermanni monroensis</i>	do.	do.	E	170	17.95(a)	NA
Rat, sick-nest	<i>Leportus conditor</i>	Australia	do.	E	2	17.95(a)	NA
Rat-kangaroo, brush-tailed	<i>Bettongia penicillata</i>	do.	do.	E	6	NA	NA
Rat-kangaroo, Gaimard's	<i>Bettongia gaimardi</i>	do.	do.	E	4	NA	NA
Rat-kangaroo, Lesueur's	<i>Bettongia lesueur</i>	do.	do.	E	4	NA	NA
Rat-kangaroo, plain	<i>Caloprymnus campestris</i>	do.	do.	E	6	NA	NA
Rat-kangaroo, Queensland	<i>Bettongia tropica</i>	do.	do.	E	4	NA	NA
Rhinoceros, black	<i>Diceros bicornis</i>	Sub-Saharan Africa	do.	E	4	NA	NA
Rhinoceros, great Indian	<i>Rhinoceros unicornis</i>	India, Nepal	do.	E	97	NA	NA
Rhinoceros, Javan	<i>Rhinoceros sondaicus</i>	Indonesia, Indochina, Burma, Thailand, Sikkim, Bangladesh, Malaysia	do.	E	3	NA	NA
Rhinoceros, northern white	<i>Ceratotherium simum cottoni</i>	Zaire, Sudan, Uganda, Central African Republic	do.	E	3	NA	NA
Rhinoceros, Sumatran	<i>Dicorhinus (= Dimeroceros) sumatrensis</i>	Bangladesh to Vietnam to Indonesia (Borneo)	do.	E	3	NA	NA
Seal, Mongolian (antelope)	<i>Seiurus tatarica mongolica</i>	Mongolia	do.	E	15	NA	NA

60 17.11

50 CFR Ch. I (10-1-86 Edition)

Saki, southern bearded	<i>Chiropotes satanes satanes</i>	Brazil	do.	E	233	NA	NA
Saki, white-nosed	<i>Chiropotes abinus</i>	do.	do.	E	3	NA	NA
Seal, Caribbean monk	<i>Monachus tropicalis</i>	Caribbean Sea, Gulf of Mexico	do.	E	1, 2, 45	NA	NA
Seal, Hawaiian monk	<i>Monachus schauinslandi</i>	U.S.A. (HI)	do.	E	15	NA	NA
Seal, Mediterranean monk	<i>Monachus monachus</i>	Mediterranean, Northwest African Coast and Black Sea	do.	E	8	NA	NA
Seledang (= Gaur)	<i>Bos gaurus</i>	Bangladesh, Southeast Asia, India	do.	E	3	NA	NA
Serval	<i>Capricornis sumatrensis</i>	East Asia, Sumatra	do.	E	3	NA	NA
Serval, Barbary	<i>Felis serval concolor</i>	do.	do.	E	15	NA	NA
Sheep	<i>Ovis vignei vignei</i>	Algeria	do.	E	15	NA	NA

U.S. Fish and

Baki, southern bearded	<i>Chiropterus satanas satanas</i>	Brazil	do	E	833	NA	NA	U.S. Fish and Wildlife Serv., Interior
Baki, white-nosed	<i>Chiropterus albinus</i>	do	do	E	3	NA	NA	
Beal, Caribbean monk	<i>Alouatta palliata</i>	Caribbean Sea, Gulf of Mexico	do	E	1, 2, 46	NA	NA	
Beal, Hawaiian monk	<i>Alouatta schauinslandi</i>	U.S.A. (HI)	do	E	18	NA	NA	
Beal, Mediterranean monk	<i>Alouatta monachus</i>	Mediterranean, Northwest African Coast and Black Sea	do	E	3	NA	NA	
Beledang (= Gaur)	<i>Bos gaurus</i>	Bangladesh, Southeast Asia, India	do	E	3	NA	NA	
Barrow	<i>Caprimus sumatrensis</i>	East Asia, Sumatra	do	E	16	NA	NA	
Serval, Barbary	<i>Felis serval concolor</i>	Algeria	do	E	3	NA	NA	
Shapo	<i>Ovis vignei vignei</i>	Kashmir	do	E	15	NA	NA	
Shou	<i>Cervus elaphus wallich</i>	Tibet, Bhutan	do	E	3	NA	NA	
Shrew, Diurnal Swamp southeastern	<i>Sorex longirostris fisheri</i>	U.S.A. (VA, NC)	do	T	246	NA	NA	S 17.11
Siamang	<i>Symphalangus syndactylus</i>	Malaysia, Indonesia	do	E	15	NA	NA	
Slakes	<i>Propithecus</i> spp. (all species)	Madagascar	do	E	4	NA	NA	
Sloth, Brazilian three-toed	<i>Bradypus torquatus</i>	Brazil	do	E	3, 4	NA	NA	
Solenodon, Cuban	<i>Solenodon (Atopogale) cubensis</i>	Cuba	do	E	3	NA	NA	
Solenodon, Haitian	<i>Solenodon paradoxus</i>	Dominican Republic, Haiti	do	E	3	NA	NA	
Squirrel, Carolina northern flying	<i>Glaucomys sabrinus coloratus</i>	U.S.A. (NC, TN)	do	E	189	NA	NA	
Squirrel, Delmarva Peninsula fox	<i>Sciurus niger cinereus</i>	U.S.A. (Delmarva Peninsula to southeast PA)	Entire, except Sussex Co., DE	E	1, 161, 186	NA	NA	
Do	do	do	U.S.A. (DE—Sussex County)	XN	161	NA	17.84(a)	
Squirrel, Virginia northern flying	<i>Glaucomys sabrinus aucus</i>	U.S.A. (VA, WV)	Entire	E	189	NA	NA	S 17.11
Stag, Barbary	<i>Cervus elaphus barbarus</i>	Tunisia, Algeria	do	E	3	NA	NA	
Stag, Kashmir	<i>Cervus elaphus hanglu</i>	Kashmir	do	E	3	NA	NA	
Sund, Zanzibar	<i>Nesotragus (Nesotragus) moechalis moechalis</i>	Zanzibar (and nearby islands)	do	E	50	NA	NA	
Tahr, Arabian	<i>Hemitragus jayakari</i>	Oman	do	E	50	NA	NA	
Tamaraw	<i>Bubalus mindorensis</i>	Philippines	do	E	4	NA	NA	
Tamarin, golden-rumped (= golden-headed Tamarin; = golden-ton Marmoset)	<i>Leontopithecus (= Leontideus) spp. (all species)</i>	Brazil	do	E	3	NA	NA	
Tamarin, pied	<i>Saguinus bicolor</i>	do	do	E	16	NA	NA	
Tamarin, white-footed	<i>Saguinus leucopus</i>	Colombia	do	T	16	NA	17.40(c)	
Tapir, Asian	<i>Tapirus indicus</i>	Burma, Laos, Cambodia, Vietnam, Malaysia, Indonesia, Thailand	do	E	15	NA	NA	
Tapir, Brazilian	<i>Tapirus terrestris</i>	Colombia and Venezuela south to Paraguay and Argentina	do	E	3	NA	NA	S 17.11
Tapir, Central American	<i>Tapirus bairdii</i>	Southern Mexico to Colombia and Ecuador	do	E	3	NA	NA	
Tapir, mountain	<i>Tapirus pinchaque</i>	Colombia, Ecuador and possibly Peru and Venezuela	do	E	3	NA	NA	
Tarsier, Philippine	<i>Tarsius syrichta</i>	Philippines	do	T	16	NA	17.40(c)	
Tiger	<i>Panthera tigris</i>	Temperate and Tropical Asia	do	E	3, 6	NA	NA	
Tiger, Tasmanian (= Thylacine)	<i>Thylacynus cynocephalus</i>	Australia	do	E	3	NA	NA	
Uakari (all species)	<i>Cacajao</i> spp. (all species)	Peru, Brazil, Ecuador, Colombia, Venezuela	do	E	3	NA	NA	
Urial	<i>Ovis montanus (= orientalis) ophius</i>	Cyprus	do	E	15	NA	NA	

Species		Historic range	Variable population where endangered or threatened	Sta- tus	When listed	Critical habitat	Special rules
Common name	Scientific name						
Vicuna	<i>Vicugna vicugna</i>	South America (Andes)	do	E	3	NA	NA
Vole, Amargosa	<i>Microtus californicus californicus</i>	U.S.A. (CA)	do	E	166	17.95(a)	NA
Wallaby, banded hare	<i>Lepus maculatus</i>	Australia	do	E	4	NA	NA
Wallaby, bridled neck-tailed	<i>Drychopsalis tricolor</i>	do	do	E	4	NA	NA
Wallaby, crescent neck-tailed	<i>Drychopsalis lunata</i>	do	do	E	4	NA	NA
Wallaby, Parma	<i>Macropus parma</i>	do	do	E	4	NA	NA
Wallaby, Western hare	<i>Lepus maculatus</i>	do	do	E	4	NA	NA
Wallaby, yellow-footed rock	<i>Petrogale xanthopus</i>	do	do	E	4	NA	NA
Whale, blue	<i>Balaenoptera musculus</i>	Oceanic	do	E	6	NA	NA
Whale, bowhead	<i>Balaena mysticetus</i>	Oceanic (north latitudes only)	do	E	3	NA	NA
Whale, finback	<i>Balaenoptera physalus</i>	Oceanic	do	E	3	NA	NA
Whale, gray	<i>Eschrichtius robustus</i>	North Pacific Ocean: coastal and Bering Sea	do	E	3	NA	NA
Whale, humpback	<i>Megaptera novaeangliae</i>	Oceanic	do	E	3	NA	NA
Whale, right	<i>Balaena glacialis</i>	do	do	E	3	NA	NA
Whale, Sei	<i>Balaenoptera borealis</i>	do	do	E	3	NA	NA
Whale, sperm	<i>Physeter catodon</i>	do	do	E	3	NA	NA
Wolf, gray	<i>Canis lupus</i>	Holarctic	U.S.A. (48 contiguous States, except MN), Mexico	E	1, 6, 12, 16, 35	17.95(a)	NA
Do	do	do	U.S.A. (MN)	T	36	17.95(a)	17.40(d)
Wolf, mired	<i>Chrysocyon brachyurus</i>	Argentina, Bolivia, Brazil, Paraguay, Uruguay	Entire	E	4	NA	NA
Wolf, red	<i>Canis rufus</i>	U.S.A. (southeastern U.S.A. west to central TX)	do	E	1	NA	NA
Wombat, hairy-nosed (=Barnard's and Queensland hairy-nosed)	<i>Lasiornis krefftii</i> (formerly <i>L. barnardi</i> and <i>L. gilgipoli</i>)	Australia	do	E	4, 6	NA	NA
Woodrat, Key Largo	<i>Neotoma floridana smalli</i>	U.S.A. (FL)	do	E	131E, 180	NA	NA
Yak, wild	<i>Bos grunniens</i>	China (Tibet), India	do	E	3	NA	NA
Zebra, Grevy's	<i>Equus grevyi</i>	Kenya, Ethiopia, Somalia	do	T	54	NA	NA
Zebra, Hartmann's mountain	<i>Equus zebra hartmannae</i>	Namibia, Angola	do	T	54, 111	NA	NA
Zebra, mountain	<i>Equus zebra zebra</i>	South Africa	do	E	16, 111	NA	NA
Birds							
Alouatta, Harell (honeycreeper)	<i>Lanius coccyzus coccyzus</i>	U.S.A. (NY)	do	E	2	NA	NA
Alouatta, Mass (honeycreeper)	<i>Lanius coccyzus ochraceus</i>	do	do	E	2	NA	NA
Alouatta, Kaul (honeycreeper)	<i>Hemiphanes procerus</i>	do	do	E	1	NA	NA
Alouatta, short-tailed	<i>Hemiphanes murrel (=wilsoni)</i>	do	do	E	1	NA	NA
Blackbird, yellow-shouldered	<i>Agelaius xanthomus</i>	North Pacific Ocean: Japan, U.S.S.R., U.S.A. (AK, CA, HI, OR, WA), U.S.A. (PR)	Entire, except U.S.A.	E	3	NA	NA

§ 17.11

50 CFR Ch. I (10-1-86 Edition)

Bobwhite, masked (quail)	<i>Colinus virginianus ridgwayi</i>	U.S.A. (AZ), Mexico (Sonora)	do	E	1, 3	NA	NA
Booby, Abbott's	<i>Sula abbotti</i>	Indian Ocean: Christmas Island	do	E	16	NA	NA
Bristlebird, western	<i>Dasyornis brachypterus longirostris</i>	Australia	do	E	3	NA	NA
Bristlebird, western rufous	<i>Dasyornis broadbentii littoralis</i>	do	do	E	16	NA	NA
Broadbill, Guam	<i>Myiagra kirkcaldii</i>	Western Pacific Ocean: U.S.A. (Guam)	do	E	16	NA	NA
Bulbul, Mauritius olivaceous	<i>Hypotaenidia borbonicus olivaceous</i>	Indian Ocean: Mauritius	do	E	156	NA	NA
Bullfinch, Sao Miguel (finch)	<i>Pyrrhula pyrrhula murina</i>	Eastern Atlantic Ocean: Azores	do	E	3	NA	NA
Bushwren, New Zealand	<i>Xenicus longipes</i>	New Zealand	do	E	2	NA	NA

U.S. Fish &

§ 17.11

[illegible]

Species		Historic range	Vertebrate population where endangered or threatened	Sta- tus	When listed	Critical habitat	Special rules
Common name	Scientific name						
Eagle, bald	<i>Haliaeetus leucocephalus</i>	North America south to northern Mexico	U.S.A. (contiguous States, except WA, OR, MN, WI, MI)	E	1, 34	NA	NA
Do	do	do	U.S.A. (WA, OR, MN, WI, MI)	T	34	NA	17.41(a)
Eagle, Greenland white-tailed	<i>Haliaeetus albicollis groenlandicus</i>	Greenland and adjacent Atlantic islands	do	E	16	NA	NA
Eagle, harpy	<i>Harpyia harpyja</i>	Mexico south to Argentina	do	E	16	NA	NA
Eagle, Philippine (= monkey-eating)	<i>Pithecophaga jefferyi</i>	Philippines	do	E	3	NA	NA
Eagle, Spanish imperial	<i>Aquila heliaca adalberti</i>	Spain, Morocco, Algeria	do	E	3	NA	NA
Egret, Chinese	<i>Egretta eulophotes</i>	China, Korea	do	E	3	NA	NA
Falcon, American peregrine	<i>Falco peregrinus anatum</i>	Nests from central Alaska across north- central Canada to central Mexico, win- ters south to South America	do	E	2, 3, 145	17.05(b)	NA
Falcon, Arctic peregrine	<i>Falco peregrinus tundrius</i>	Nests from northern Alaska to Green- land, winters south to Central and South America	do	T	2, 3, 145	NA	NA
Falcon, Eurasian peregrine	<i>Falco peregrinus peregrinus</i>	Europe, Eurasia south to Africa and Mid- east	do	E	16	NA	NA
Falcon, northern aptomado	<i>Falco femoralis septentrionalis</i>	U.S.A. (AZ, NM, TX), Mexico, Guatemala	do	E	210	NA	NA
Falcon, peregrine	<i>Falco peregrinus</i>	Worldwide, except Antarctica and most Pacific islands	Wherever found in wild in the contiguous 48 States	E(S/A)	145	NA	NA
Finch, Laysan (honeycreeper)	<i>Telespiza (= Psittirostra) cantans</i>	U.S.A. (HI)	Entire	E	1	NA	NA
Finch, Nihoa (honeycreeper)	<i>Telespiza (= Psittirostra) ulana</i>	do	do	E	1	NA	NA
Flycatcher, Euler's	<i>Empidonax euleri johnstoni</i>	West Indies: Grenada	do	E	3	NA	NA
Flycatcher, Seychelles paradise	<i>Terpsiphone corvina</i>	Indian Ocean: Seychelles	do	E	3	NA	NA
Flycatcher, Tahiti	<i>Pomarea nigra</i>	South Pacific Ocean: Tahiti	do	E	3	NA	NA
Fody, Seychelles (weaver-finch)	<i>Foudia sechellarum</i>	Indian Ocean: Seychelles	do	E	3	NA	NA
Frigatebird, Andrew's	<i>Fregata andrewsi</i>	East Indian Ocean	do	E	3	NA	NA
Goose, Aleutian Canada	<i>Branta canadensis leucopareia</i>	U.S.A. (AK, CA, OR, WA), Japan	do	E	16	NA	NA
Goose, Hawaiian (= nene)	<i>Branta (= Branta) sandvicensis</i>	U.S.A. (HI)	do	E	1, 3	NA	NA
Goshawk, Christmas Island	<i>Accipiter fasciatus natalis</i>	do	do	E	1	NA	NA
Grackle, slender-billed	<i>Cusickia (= Cassin's) palustris</i>	Indian Ocean: Christmas Island	do	E	3	NA	NA
Grasswren, Eyrean (flycatcher)	<i>Amphispiza bilineata</i>	Mexico	do	E	3	NA	NA
Grebe, Australian	<i>Podilymbus nigrescens</i>	Australia	do	E	3	NA	NA
Greenshank, Nordmann's	<i>Tringa guttifer</i>	Guatemala	do	E	3	NA	NA
Guan, horned	<i>Oreophaps derbianus</i>	U.S.S.R., Japan, south to Malaysia, Borneo	do	E	3	NA	NA
Gull, Audouin's	<i>Larus audouinii</i>	Guatemala, Mexico	do	E	3	NA	NA
Gull, relict	<i>Larus relictus</i>	Mediterranean Sea	do	E	3	NA	NA
Hawk, Anjouan Island sparrow	<i>Accipiter francesi pueblus</i>	India, China	do	E	16	NA	NA
		Indian Ocean: Comoro Islands	do	E	3	NA	NA

§ 17.11

50 CFR Ch. I (10-1-86 Edition)

Hawk, Galapagos	<i>Buteo galapagoensis</i>	Ecuador (Galapagos Islands)	do	E	3	NA	NA
Hawk, Hawaiian (= io)	<i>Buteo burtlandi</i>	U.S.A. (HI)	do	E	1	NA	NA
Hermit, hook-billed (hummingbird)	<i>Glaucis (= Ramphodon) dolomi</i>	Brazil	do	E	16	NA	NA
Honeycreeper, crested (= akohakeke)	<i>Palmeria dolei</i>	U.S.A. (HI)	do	E	1	NA	NA
Hornbill, helmeted	<i>Rhinoplax vigil</i>	Thailand, Malaysia	do	E	16	NA	NA
Honeyeater, helmeted	<i>Meliphaga casakia</i>	Australia	do	E	4	NA	NA
Ibis, Japanese crested	<i>Nipponia nippon</i>	China, Japan, U.S.S.R., Korea	do	E	3	NA	NA
Kagu	<i>Rhynchotus jubatus</i>	South Pacific Ocean: New Caledonia	do	E	3	NA	NA
Kakapo (= owl parrot)	<i>Strigops habroptilus</i>	New Zealand	do	E	3	NA	NA

U.S. Fish and

[illegible]

Pigeon, Mindoro zone-tailed
Pigeon, Puerto Rican plain

Ducula mindorensis
Columba homa wetmorei

Philippine
U.S.A.

2443219-0500

E

18

NA

NA

Item)

Piping-guan, black-fronted
Pitta, Koch's
Plover, New Zealand shore
Plover, piping

Pipilo megalonyx
Pitta kochi
Thinornis novaezeelandiae
Charadrius melodus

Argentina
Philippines
New Zealand
U.S.A. (Great Lakes, northern Great
Plains, Atlantic and Gulf coasts, PR
VI), Canada, Mexico, Bahamas, West
Indies.

do
do
do
Great Lakes
watershed in
States of IL, IN,
MI, MN, NY, OH,
PA, and WI and
Province of
Ontario.

E
E
E
E

18
18
3
211

NA
NA
NA
NA

NA
NA
NA
NA

Do

do

do

Entire, except
those areas
where listed as
endangered
above.

T

211

NA

NA

Po'ouli (honeyscreper)
Prairie-chicken, Altwater's greater
Quail, Merriam's Montezuma
Quetzal, resplendent
Rail, Auckland Island
Rail, California clapper
Rail, Guam

Melanerpes formicivorus
Tympanuchus cupido altwateri
Cyrtonyx montezumae merriami
Phapitreron montezumae
Rallus longirostris muelleri
Rallus longirostris obsoletus
Rallus owstoni

U.S.A. (HI)
U.S.A. (TX)
Mexico (Veracruz)
Mexico to Panama
New Zealand
U.S.A. (CA)
Western Pacific Ocean: U.S.A. (Guam)

Entire
do
do
do
do
do
do

E
E
E
E
E
E
E

10
1
15
15
3
2
148E

NA
NA
NA
NA
NA
NA
NA

NA
NA
NA
NA
NA
NA
NA

Rail, light-footed clapper
Rail, Lord Howe wood

Rallus longirostris leucipes
Trochilinae sylvestris

U.S.A. (CA), Mexico (Baja California)
Australia (Lord Howe Island)

do
do

E
E

2
15

NA
NA

NA
NA

Rail, Yuma clapper

Rallus longirostris yumanensis

Mexico, U.S.A. (AZ, CA)

do

E

1

NA

NA

Rhea, Darwin's

Pterocnemia pennata

Argentina, Bolivia, Peru, Uruguay

do

E

3

NA

NA

Robin, Chatham Island

Erithacus tricolor

New Zealand

do

E

3

NA

NA

Robin, scarlet-breasted (flycatcher)

Petroica multicolor multicolor

Australia (Norfolk Island)

do

E

3

NA

NA

Rocklowl, grey-necked

Picathartes oreas

Cameroon, Gabon

do

E

3

NA

NA

Rocklowl, white-necked

Picathartes gymnocephalus

Africa: Togo to Sierra Leone

do

E

3

NA

NA

Roller, long-tailed ground

Uroloncha chimaera

Madagascar Republic (= Madagascar)

do

E

3

NA

NA

Scrub-bird, noisy

Atrichornis clamosus

Australia

do

E

3

NA

NA

Shama, Cebu black (thrush)

Copsychus niger cebuensis

Philippines

do

E

3

NA

NA

Shearwater, Newell's Townsend's (formerly Menus) (= 'A's)

Puffinus auricularis (formerly puffinus)
newelli

U.S.A. (HI)

do

T

10

NA

NA

Shrike, San Clemente loggerhead

Lanius ludovicianus excubitorides

U.S.A. (CA)

do

E

26

NA

NA

Biskin, red

Carduelis (= Spizus) cucullata

South America

do

E

15

NA

NA

Sparrow, Cape Sable seaside

Ammodramus (= Ammospiza) maritimus
mirabilis

U.S.A. (FL)

do

E

1

17.85(b)

NA

Sparrow, dusky seaside

Ammodramus (= Ammospiza) maritimus
nigrescens

do

do

E

1

17.85(b)

NA

Sparrow, Florida grasshopper

Ammodramus sepiarium floridanus

do

do

E

239

NA

NA

Sparrow, San Clemente sage

Ammodramus bulli clementiae

U.S.A. (CA)

do

T

26

NA

NA

Starling, Ponape mountain

Aplonis pateri

West Pacific Ocean: U.S.A. (Caroline Is-lands)

do

E

3

NA

NA

Starling, Rothschild's (myna)

Leucopsar rothschildi

Indonesia (Bali)

do

E

3

NA

NA

U.S. Fish and Wildlife Serv., Interior

\$ 17.11

Species		Historic range	Vertebrate population where endangered or threatened	Sta- tus	When listed	Critical habitat	Special rules
Common name	Scientific name						
Sooty, Hawaiian (=As'o)	<i>Himantopus mexicanus</i> (= <i>himantopus</i>) <i>knudseni</i>	U.S.A. (Hawaii)	do	E	2	NA	NA
Stork, oriental white	<i>Ciconia ciconia boyciana</i>	China, Japan, Korea, U.S.S.R.	do	E	3	NA	NA
Stork, wood	<i>Mycteria americana</i>	U.S.A., (CA, AZ, TX, to Carolinas), Mexico, Central and South America.	U.S.A. (AL, FL, GA, SC)	E	142	NA	NA
Swiftlet, Mariana gray (=Vanikoro)	<i>Aerodramus</i> (= <i>Collocalia</i>) <i>vanikoroensis</i> <i>bartschi</i>	Western Pacific Ocean: U.S.A. (Guam, Rota, Tinian, Saipan, Agiguan)	Entire	E	156	NA	NA
Teal, Campbell Island flightless	<i>Anas aucklandica nesiotis</i>	New Zealand (Campbell Island)	do	E	15	NA	NA
Tern, California least	<i>Sterna antillarum</i> (= <i>albigularis</i>) <i>browni</i>	Mexico, U.S.A. (CA)	do	E	2, 3	NA	NA
Tern, least	<i>Sterna antillarum</i>	U.S.A. (Atlantic and Gulf coasts, Miss. R. Basin, CA), Gr. and Lesser Antilles, Bahamas, Mexico; winters C. America, northern S. America.	U.S.A. (AR, CO, IA, IL, IN, KS, KY, LA (Miss. R. and tribe N of Baton Rouge), MS (Miss. R.), MO, MT, NE, NM, ND, OK, SD, TN, TX (Except within 50 miles of coast)).	E	182	NA	NA
Thrasher, white-breasted	<i>Ramphocinclus brachyurus</i>	West Indies: St. Lucia, Martinique	Entire	E	3	NA	NA
Thrush, large Kauai (=puehi)	<i>Myadestes</i> (= <i>Phaeornis</i>) <i>myadestinus</i>	U.S.A. (HI)	do	E	2	NA	NA
Thrush, Molokai (=oloma'o)	<i>Myadestes</i> (= <i>Phaeornis</i>) <i>laniensis</i> (= <i>obscurus</i>) <i>rufa</i>	do	do	E	2	NA	NA
Thrush, New Zealand (wattlebird)	<i>Tumagra capensis</i>	New Zealand	do	E	3	NA	NA
Thrush, small Kauai (=puehi)	<i>Myadestes</i> (= <i>Phaeornis</i>) <i>palmieri</i>	U.S.A. (HI)	do	E	1	NA	NA
Tinamou, solitary	<i>Tinamus solitarius</i>	Brazil, Paraguay, Argentina	do	E	16	NA	NA
Trembler, Martinique (thrasher)	<i>Cincloerchia ruficauda gutturalis</i>	West Indies: Martinique	do	E	3	NA	NA
Vireo, least Bell's	<i>Vireo bellii pusillus</i>	U.S.A. (CA), Mexico	do	E	228	NA	NA
Wanderer, plain (collared-hempode)	<i>Pedionomus torquatus</i>	Australia	do	E	6	NA	NA
Warbler (wood), Bachman's	<i>Vermivora bachmani</i>	U.S.A. (Southeastern), Cuba	do	E	1, 3	NA	NA
Warbler (wood), Barbados yellow	<i>Dendroica petechia petechia</i>	West Indies: Barbados	do	E	3	NA	NA
Warbler (wood), Kirtland's	<i>Dendroica kirtlandi</i>	U.S.A. (principally MI), Canada, West Indies: Bahama Islands.	do	E	1, 3	NA	NA
Warbler (willow), nightingale reed	<i>Acrocephalus luscivus</i>	Western Pacific Ocean	U.S.A. (Mariana Islands).	E	3, 4	NA	NA
Warbler (willow), Rodrigues	<i>Babronia rodericana</i>	Mauritius (Rodrigues Islands)	Entire	E	3	NA	NA
Warbler (wood), Semper's	<i>Leucophaea semperi</i>	West Indies: St. Lucia	do	E	3	NA	NA
Warbler (willow), Seychelles	<i>Babronia sechellensis</i>	Indian Ocean: Seychelles Island	do	E	3	NA	NA
Whipbird, Western	<i>Pachyodes nigrogularis</i>	Australia	do	E	3	NA	NA
White-eye, bridled	<i>Zosterops conspicillata conspicillata</i>	Western Pacific Ocean: U.S.A. (Guam)	do	E	156	NA	NA
White-eye, Norfolk Island	<i>Zosterops albogularis</i>	Indian Ocean: Norfolk Islands	do	E	15	NA	NA
White-eye, Ponape greater	<i>Rukia longirostris</i> (= <i>sanfordi</i>)	West Pacific Ocean: U.S.A. (Caroline Islands).	do	E	3	NA	NA

White-eye, Seychelles	<i>Zosterops modesta</i>	Indian Ocean: Seychelles	do	E	3	NA	NA
Woodpecker, imperial	<i>Campylorhynchus imperialis</i>	Mexico	do	E	3	NA	NA
Woodpecker, ivory-billed	<i>Campylorhynchus principalis</i>	U.S.A. (southeastern and southeastern), Cuba	do	E	1, 3	NA	NA
Woodpecker, red cockaded	<i>Picoides</i> (= <i>Dendrocoptes</i>) <i>borealis</i>	U.S.A. (southeastern and southeastern)	do	E	3	NA	NA
Woodpecker, Tristram's	<i>Dryocopus javensis richardsoni</i>	Korea	do	E	3	NA	NA
Wren, Guadeloupe house	<i>Troglodytes aedon guadeloupensis</i>	West Indies: Guadeloupe	do	E	3	NA	NA
Wren, St. Lucia house	<i>Troglodytes aedon mesoleucus</i>	West Indies: St. Lucia	do	E	3	NA	NA

REPTILES

§ 17.11

50 CFR Ch. I (10-1-86 Edition)

U.S. Fish and

White-eye, Norfolk Island
White-eye, Ponape greater

Zosterops siroehensis
Rukia longirostris (= sanfordi)

Pacific Ocean: U.S.A. (Guam)
s)

E 3 NA NA

ition)

7-186 0-28-1

89

White-eye, Seychelles	<i>Zosterops modesta</i>	Indian Ocean: Seychelles	do	E	3	NA	NA
Woodpecker, imperial	<i>Campephilus imperialis</i>	Mexico	do	E	3	NA	NA
Woodpecker, ivory-billed	<i>Campephilus principalis</i>	U.S.A. (southcentral and southeastern), Cuba	do	E	1, 2	NA	NA
Woodpecker, red-cockaded	<i>Picoides</i> (= <i>Dendrocopos</i>) <i>borealis</i>	U.S.A. (southcentral and southeastern)	do	E	2	NA	NA
Woodpecker, Tristram's	<i>Dryocopus javensis richardsi</i>	Korea	do	E	3	NA	NA
Wren, Guadeloupe house	<i>Troglodytes aedon guadeloupenis</i>	West Indies: Guadeloupe	do	E	3	NA	NA
Wren, St. Lucia house	<i>Troglodytes aedon mesoleucus</i>	West Indies: St. Lucia	do	E	3	NA	NA
REPTILES							
Alligator, American	<i>Alligator mississippiensis</i>	Southeastern U.S.A.	Wherever found in wild except those areas where listed as threatened as set forth below	E	1, 11, 51, 60, 113, 134, 186	NA	NA
Do	do	do	U.S.A. (certain areas of GA and SC, as set forth in 17.42(a)(1)). 17.42(a)(1)).	T	20, 47, 51, 60, 134, 186	NA	17.42(a)
Do	do	do	U.S.A. (FL, LA and TX); in captivity wherever found	T(S/A)	11, 47, 51, 60, 113, 134, 186	NA	17.42(a)
Alligator, Chinese	<i>Alligator sinensis</i>	China	Entire	E	15	NA	NA
Anole, Culebra Island giant	<i>Anolis roosevelti</i>	U.S.A. (PR: Culebra Island)	do	E	25	17.95(c)	NA
Boa, Jamaican	<i>Epicrates subflavus</i>	Jamaica	do	E	3	NA	NA
Boa, Mona	<i>Epicrates monensis monensis</i>	U.S.A. (PR)	do	T	33	17.95(c)	NA
Boa, Puerto Rico	<i>Epicrates inornatus</i>	do	do	E	2	NA	NA
Boa, Round Island (no common name)	<i>Casarea dussumieri</i>	Indian Ocean: Mauritius	do	E	88	NA	NA
Boa, Round Island (no common name)	<i>Boyeria multocarinata</i>	do	do	E	88	NA	NA
Boa, Virgin Islands tree	<i>Epicrates monensis grandis</i>	U.S. and British Virgin Islands	do	E	2, 88	NA	NA
Calman, Apaporis River	<i>Caiman crocodilus apaporisensis</i>	Colombia	do	E	15	NA	NA
Calman, black	<i>Melanosuchus niger</i>	Amazon basin	do	E	15	NA	NA
Calman, broad-snouted	<i>Caiman latirostris</i>	Brazil, Argentina, Paraguay, Uruguay	do	E	15	NA	NA
Calman, Yacare	<i>Caiman crocodilus yacare</i>	Bolivia, Argentina, Peru, Brazil	do	E	3	NA	NA
Chuckwalla, San Esteban Island	<i>Sauromastus varius</i>	Mexico	do	E	88	NA	NA
Crocodile, African dwarf	<i>Osteoleaemus tetraspis tetraspis</i>	West Africa	do	E	15	NA	NA
Crocodile, African slender-snouted	<i>Crocodylus cataphractus</i>	Western and central Africa	do	E	6	NA	NA
Crocodile, American	<i>Crocodylus acutus</i>	U.S.A. (FL), Mexico, South America, Cen- tral America, Caribbean	do	E	10, 87	17.95(c)	NA
Crocodile, Ceylon mugger	<i>Crocodylus palustris limbatus</i>	Sri Lanka	do	E	15	NA	NA
Crocodile, Congo dwarf	<i>Osteoleaemus tetraspis osborni</i>	Congo River drainage	do	E	15	NA	NA
Crocodile, Cuban	<i>Crocodylus rhomboides</i>	Cuba	do	E	3	NA	NA
Crocodile, Morelet's	<i>Crocodylus moreletii</i>	Mexico, Belize, Guatemala	do	E	3	NA	NA
Crocodile, mugger	<i>Crocodylus palustris palustris</i>	India, Pakistan, Iran, Bangladesh	do	E	15	NA	NA
Crocodile, Nile	<i>Crocodylus niloticus</i>	Africa	do	E	3	NA	NA

U.S. Fish and Wildlife Serv., Interior

9 17.11

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Crocodile, Orinoco.....	<i>Crocodylus intermedius</i>	South America: Orinoco River Basin	do	E	3	NA	NA
Crocodile, Philippine.....	<i>Crocodylus novaeaguineae mindonensis</i>	Philippine Islands	do	E	15	NA	NA
Crocodile, saltwater (= estuarine).....	<i>Crocodylus porosus</i>	Southeast Asia, Australia, Papua-New Guinea, Pacific Islands	Entire, except Papua-New Guinea	E	87	NA	NA
Crocodile, Siamese.....	<i>Crocodylus siamensis</i>	Southeast Asia, Malay Peninsula	Entire	E	15	NA	NA
Gaviel (= gharial).....	<i>Gavialis gangeticus</i>	Pakistan, Burma, Bangladesh, India, Nepal	do	E	3, 15	NA	NA
Gecko, day.....	<i>Phelsuma edwardnewtoni</i>	Indian Ocean: Mauritius	do	E	3	NA	NA
Gecko, Monto.....	<i>Sphaerodactylus micropithecus</i>	U.S.A. (PR)	do	E	125	17.95(c)	NA
Gecko, Round Island day.....	<i>Phelsuma guentheri</i>	Indian Ocean: Mauritius	do	E	3	NA	NA
Gecko, Serpent Island.....	<i>Cylindrodactylus serpensinsula</i>	do	do	T	129	NA	NA
Iguana, Acklins ground.....	<i>Cyclura nileyi nuchalis</i>	West Indies: Bahamas	do	T	129	NA	NA
Iguana, Allen's Cay.....	<i>Cyclura cyclura inornata</i>	do	do	T	129	NA	NA
Iguana, Andros Island ground.....	<i>Cyclura cyclura cyclura</i>	do	do	T	129	NA	NA
Iguana, Anegada ground.....	<i>Cyclura pinguis</i>	West Indies: British Virgin Islands (Anegada Island)	do	E	3	NA	NA
Iguana, Barrington land.....	<i>Conolophus pallidus</i>	Ecuador (Galapagos Islands)	do	E	3	NA	NA
Iguana, Cayman Brac ground.....	<i>Cyclura rubra caymanensis</i>	West Indies: Cayman Islands	do	T	129	NA	NA
Iguana, Cuban ground.....	<i>Cyclura rubra rubra</i>	Cuba	Entire (excluding population introduced in Puerto Rico)	T	129	NA	NA
Iguana, Exuma Island.....	<i>Cyclura cyclura fignalis</i>	West Indies: Bahamas	Entire	T	129	NA	NA
Iguana, Fiji banded.....	<i>Brachyophis fasciatus</i>	Pacific: Fiji, Tonga	do	E	88	NA	NA
Iguana, Fiji crested.....	<i>Brachyophis vitiensis</i>	Pacific: Fiji	do	E	88	NA	NA
Iguana, Grand Cayman ground.....	<i>Cyclura rubra lewisi</i>	West Indies: Cayman Islands	do	E	129	NA	NA
Iguana, Jamaican.....	<i>Cyclura collei</i>	West Indies: Jamaica	do	E	129	NA	NA
Iguana, Mayaguana.....	<i>Cyclura carinata bartschi</i>	West Indies: Bahamas	do	T	129	NA	NA
Iguana, Mona ground.....	<i>Cyclura stehnegeri</i>	U.S.A. (PR: Mona Island)	do	T	33	17.95(c)	NA
Iguana, Turks and Caicos.....	<i>Cyclura carinata carinata</i>	West Indies: Turks and Caicos Islands	do	T	129	NA	NA
Iguana, Walling Island ground.....	<i>Cyclura nileyi nileyi</i>	West Indies: Bahamas	do	E	129	NA	NA
Iguana, White Cay ground.....	<i>Cyclura nileyi cristata</i>	do	do	T	129	NA	NA
Lizard, blunt-nosed leopard.....	<i>Gambusia (= Crotophytus) silus</i>	U.S.A. (CA)	do	E	1	NA	NA
Lizard, Coachella Valley fringe-toed.....	<i>Uma inornata</i>	do	do	T	105	17.95(c)	NA
Lizard, Herreria giant.....	<i>Gallotia simonyi simonyi</i>	Spain (Canary Islands)	do	E	144	NA	NA
Lizard, Ibiza wall.....	<i>Podarcis pityusensis</i>	Spain (Balearic Islands)	do	T	144	NA	NA
Lizard, Island night.....	<i>Xantusia (= Kleuberina) riveriensis</i>	U.S.A. (CA)	do	T	26	NA	NA
Lizard, St. Croix ground.....	<i>Anolis polops</i>	U.S.A. (VI)	do	E	24	17.95(c)	NA
Monitor, Bengal.....	<i>Varanus bengalensis</i>	Iran, Iraq, India, Sri Lanka, Malaysia, Afghanistan, Burma, Vietnam, Thailand	do	E	15	NA	NA

Monitor, desert.....	<i>Varanus griseus</i>	North Africa to Near East, Caspian Sea through U.S.S.R. to Pakistan, Northwest India	do	E	18	NA	NA
Monitor, Komodo Island.....	<i>Varanus komodoensis</i>	Indonesia	do	E	18	NA	NA

§ 17.11

50 CFR Ch. I (10-1-86 Edition)

U.S.

Monitor, desert	<i>Varanus griseus</i>	North Africa to Near East, Caspian Sea through U.S.S.R. to Pakistan, North-west India	do	E	18	NA	NA
Monitor, Komodo Island	<i>Varanus komodoensis</i>	Indonesia (Komodo, Rinja, Pader, and western Flores Island)	do	E	16	NA	NA
Monitor, yellow	<i>Varanus flavescens</i>	West Pakistan through India to Bangladesh	do	E	15	NA	NA
Python, Indian	<i>Python molurus molurus</i>	Sri Lanka and India	do	E	16	NA	NA
Rattlesnake, Aruba Island	<i>Crotalus unicolor</i>	Aruba Island (Netherlands Antilles)	do	T	129	NA	NA
Rattlesnake, New Mexican ridge-nosed	<i>Crotalus willardi obovatus</i>	U.S.A. (NM), Mexico	do	T	43	17.95(c)	NA
Skink, Round Island	<i>Leiolopisma telfairi</i>	Indian Ocean: Mauritius	do	T	129	NA	NA
Snake, Atlantic salt marsh	<i>Nerodia fasciata tenella</i>	U.S.A. (FL)	do	T	30	NA	NA
Snake, Concho water	<i>Nerodia harti paucimaculata</i>	U.S.A. (TX)	do	T	241	NA	NA
Snake, eastern indigo	<i>Drymarchon corais couperi</i>	U.S.A. (AL, FL, GA, MS, SC)	do	T	32	NA	NA
Snake, San Francisco garter	<i>Thamnophis sirtalis tetrataenia</i>	U.S.A. (CA)	do	E	1	NA	NA
Tartaruga	<i>Podocnemis expansa</i>	South America: Orinoco and Amazon River basins	do	E	3	NA	NA
Terrapin, river (=Turtle)	<i>Batagur baska</i>	Malaysia, Bangladesh, Burma, India, Indonesia	do	E	3	NA	NA
Tomistoma	<i>Tomistoma schlegelii</i>	Malaysia, Indonesia	do	E	15	NA	NA
Tortoise, angulated	<i>Geochelone mydas</i>	Malagasy Republic (=Madagascar)	do	E	15	NA	NA
Tortoise, Bolson	<i>Gopherus flavomarginatus</i>	Mexico	do	E	48	NA	NA
Tortoise, desert	<i>Xerobates (=Scaptochelys =Gopherus) agassizii</i>	U.S.A. (UT, AZ, CA, NV); Mexico	Beaver Dam Slope, Utah	T	103	17.95(c)	NA
Tortoise, Galapagos	<i>Geochelone elephantopus</i>	Ecuador (Galapagos Islands)	Entre	E	3	NA	NA
Tortoise, radiated	<i>Geochelone (=Testudo) radiata</i>	Malagasy Republic (=Madagascar)	do	E	3	NA	NA
Tracaja	<i>Podocnemis unifilis</i>	South America: Orinoco and Amazon River basins	do	E	3	NA	NA
Turtles	<i>Sphenodon punctatus</i>	New Zealand	do	E	3	NA	NA
Turtle, aquatic box	<i>Terrapene carolina</i>	Mexico	do	E	4	NA	NA
Turtle, black softshell	<i>Trionyx nigricans</i>	Bangladesh	do	E	16	NA	NA
Turtle, Burmese peacock	<i>Morenia ocellata</i>	Burma	do	E	15	NA	NA
Turtle, Central American river	<i>Demamelys mawii</i>	Mexico, Belize, Guatemala	do	E	129	NA	NA
Turtle, Cuatro Ciénegas softshell	<i>Trionyx ater</i>	Mexico	do	E	15	NA	NA
Turtle, geometric	<i>Pseudemys geometrica (=Geochelone geometrica)</i>	South Africa	do	E	15	NA	NA
Turtle, green sea	<i>Chelonia mydas</i>	Circumglobal in tropical and temperate seas and oceans	Wherever found except where listed as endangered below	T	2, 42	NA	17.42(b) and Parts 220 and 227.
Do	do	do	Breeding colony populations in FL and on Pacific coast of Mexico	E	2, 42	NA	NA
Turtle, hawksbill sea (=carey)	<i>Eretmochelys imbricata</i>	Tropical seas	Entire	E	3	17.95(c)	NA
Turtle, Indian sawback	<i>Kachuga lewis lewis</i>	India	do	E	16	NA	NA
Turtle, Indian softshell	<i>Trionyx gangeticus</i>	Pakistan, India	do	E	15	NA	NA

U.S. Fish and Wildlife Serv., Interior

§ 17.11

Species		Historic range	Vertebrate population where endangered or threatened	Sta- tus	When listed	Critical habitat	Special rules
Common name	Scientific name						
Turtle, Kemp's (= Atlantic) Ridley sea	<i>Lepidochelys kempi</i>	Tropical and temperate seas in Atlantic Basin.	do	E	4	NA	NA
Turtle, leatherback sea	<i>Dermochelys coriacea</i>	Tropical, temperate, and subpolar seas	do	E	3	17.05(c), 228.71	NA
Turtle, loggerhead sea	<i>Caretta caretta</i>	Circumglobal in tropical and temperate seas and oceans.	do	T	42	NA	17.42(b) and Parts 220 and 227.
Turtle, Olive (Pacific) Ridley sea	<i>Lepidochelys olivacea</i>	Tropical and temperate seas in Pacific Basin.	Wherever found except where listed as endangered below.	T	42	NA	17.42(b) and Parts 220 and 227.
Do	do	do	Breeding colony populations on Pacific coast of Mexico.	E	42	NA	NA
Turtle, peacock softshell	<i>Trionyx funeri</i>	India, Bangladesh	Entire	E	15	NA	NA
Turtle, Plymouth red-bellied	<i>Pseudemys (= Chrysemys) rubriventris bangsi</i>	U.S.A. (MA)	do	E	90	17.05(c)	NA
Turtle, short-necked or western swamp	<i>Pseudemys urbinia</i>	Australia	do	E	3	NA	NA
Turtle, spotted pond	<i>Geoclemys (= Demonia) hamiltoni</i>	North India, Pakistan	do	E	15	NA	NA
Turtle, three-keeled Asian	<i>Melanochelys (= Geoemyda, Alcoria) trifasciata</i>	Central India to Bangladesh and Burma	do	E	15	NA	NA
Viper, Lar Valley	<i>Viper isithi</i>	Iran	do	E	129	NA	NA
AMPHIBIANS							
Coqui, golden	<i>Eleutherodactylus jasper</i>	U.S.A. (PR)	do	T	29	17.05(d)	NA
Frog, large painted	<i>Discoglossus nigriventris</i>	Israel	do	E	3	NA	NA
Frog, Panamanian golden	<i>Aleopus varus zetek</i>	Panama	do	E	15	NA	NA
Frog, Stephen island	<i>Leiopelma hamiltoni</i>	New Zealand	do	E	3	NA	NA
Salamander, Chinese giant	<i>Andrias davidianus davidianus</i>	Western China	do	E	15	NA	NA
Salamander, desert slender	<i>Batrachoseps atrox</i>	U.S.A. (CA)	do	E	8	NA	NA
Salamander, Japanese giant	<i>Andrias davidianus japonicus</i>	Japan	do	E	15	NA	NA
Salamander, Red Hills	<i>Phaeognathus rubricollis</i>	U.S.A. (AL)	do	T	19	NA	NA
Salamander, San Marcos	<i>Eurycea nana</i>	U.S.A. (TX)	do	T	98	17.05(d)	17.43(a)
Salamander, Santa Cruz long-toed	<i>Amphystoma macrodactylum crookum</i>	U.S.A. (CA)	do	E	1	NA	NA
Salamander, Texas blind	<i>Typhlomolge rathbuni</i>	U.S.A. (TX)	do	E	1	NA	NA
Toad, African viviparous	<i>Nectophrynoides spp.</i>	Tanzania, Guinea, Ivory Coast, Cameroon, Liberia, Ethiopia	do	E	15	NA	NA
Toad, Cameroonian	<i>Bufo superciliosus</i>	Equatorial Africa	do	E	15	NA	NA
Toad, Houston	<i>Bufo houstonensis</i>	U.S.A. (TX)	do	E	2	17.05(d)	NA
Toad, Monte Verde	<i>Bufo perigrinus</i>	Costa Rica	do	E	15	NA	NA

§ 17.11

50 CFR Ch. I (10-1-86 Edition)

Toad, Wyoming	<i>Bufo hemiophysus baxteri</i>	U.S.A. (WY)	do	E	138	NA	NA
FISHES							
Ala Baki (trout)	<i>Salmo platycephalus</i>	Turkey	Entire	E	3	NA	NA
Ayamodoki (loach)	<i>Hymenophysa (= Bolla) curta</i>	Japan	do	E	3	NA	NA
Blindcat, Mexican (catfish)	<i>Priolepis phreatophila</i>	Mexico	do	E	3	NA	NA
Bonytongue, Asian	<i>Scleropages formosus</i>	Thailand, Indonesia, Malaysia	do	E	1	NA	NA
Caillieh (no common name)	<i>Pangasius sutchim</i>	Thailand, Indonesia, Malaysia	do	E	1	NA	NA

U.S. Fish &

U.S. Fish and Wildlife Serv., Interior

[illegible]

§ 17.11

[illegible]

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Spiny mussel, Tar River	<i>Elliptio (Cantharis) steinstansana</i>	U.S.A. (NC)	NA	E	188	NA	NA
CRUSTACEANS							
Amphipod, Hay's Spring	<i>Stygobromus hayi</i>	U.S.A. (DC)	NA	E	118	NA	NA
Crayfish, Nashville	<i>Orconectes shoupi</i>	U.S.A. (TN)	NA	E	242	NA	NA
Isopod, Madison Cave	<i>Anisolas ira</i>	U.S.A. (VA)	NA	T	123	NA	17.48(a)
Isopod, Socorro	<i>Thermosphaeroma thermophilus</i> (= <i>Erosphaeroma</i>)	U.S.A. (NM)	NA	E	38	NA	NA
Shrimp, Kentucky cave	<i>Palaemonias gartleri</i>	U.S.A. (KY)	NA	E	138	17.95(b)	NA
INSECTS							
Beetle, delta green ground	<i>Elaphrus viridis</i>	U.S.A. (CA)	NA	T	100	17.95(b)	NA
Beetle, valley elderberry longhorn	<i>Desmocerus californicus dimorphus</i>	do	NA	T	88	17.95(b)	NA
Butterfly, El Segundo blue	<i>Euphilotes (= Shilimacoides) bellatoides allyni</i>	do	NA	E	14	NA	NA
Butterfly, Lange's metalmark	<i>Apodemia mormo langi</i>	do	NA	E	14	NA	NA
Butterfly, lotis blue	<i>Lycaides argyrognomon lotis</i>	do	NA	E	14	NA	NA
Butterfly, mission blue	<i>Icaricia icaroides missionensis</i>	do	NA	E	14	NA	NA
Butterfly, Oregon silverspot	<i>Speyeria zerene hippolyte</i>	U.S.A. (OR, WA)	NA	T	86	17.95(b)	NA
Butterfly, Palos Verdes blue	<i>Glaucopsyche lygdamus palosverdesensis</i>	U.S.A. (CA)	NA	E	86	17.95(b)	NA
Butterfly, San Bruno elfin	<i>Calliphrys mossii bayensis</i>	do	NA	E	14	NA	NA
Butterfly, Scheus swallowtail	<i>Heracles (= Papilio) aristodemus ponceanus</i>	U.S.A. (FL)	NA	E	13, 158	NA	NA
Butterfly, Smith's blue	<i>Euphilotes (= Shilimacoides) enoplos smithi</i>	U.S.A. (CA)	NA	E	14	NA	NA
Moth, Kern pinworm aphix	<i>Euproserpinus euterpe</i>	do	NA	T	81	NA	NA
Newcomb, Ash Meadows	<i>Ambrysus amargosus</i>	U.S.A. (NV)	NA	T	181	17.95(b)	NA

EDITORIAL NOTE: For "When listed" citations, see list following; for symbols in "When listed" see below:
#--Indicates FA where species was deleted; # following of the species is indicated by subsequent number.
E--Indicates Emergency order publication in FA.

E—Indicates Emergency rule publication (see FR document for effective dates); subsequent number(s) indicate FR final rule, if applicable under "When Filed"

- 1-32 FR 4001: March 11, 1967.
2-35 FR 18047: October 12, 1970.
3-35 FR 8495: June 2, 1970.
4-35 FR 18320: December 2, 1970.
5-37 FR 6476: March 30, 1972.
6-38 FR 14678: June 4, 1973.
7-39 FR 44991: December 30, 1974.
8-40 FR 29864: July 16, 1975.
9-40 FR 31738: July 28, 1975.
10-40 FR 44151: September 23, 1975.
11-40 FR 44418: September 26, 1975.
12-40 FR 47506: October 9, 1975.
13-41 FR 17740: April 28, 1976.
14-41 FR 22044: June 1, 1976.
15-41 FR 24064: June 14, 1976.
16-41 FR 45993: October 19, 1976.
17-41 FR 51021: November 19, 1976.
18-41 FR 51612: November 23, 1976.
19-41 FR 53034: December 3, 1976.
20-42 FR 2076: January 10, 1977.
21-42 FR 2968: January 14, 1977.
22-42 FR 15971: March 24, 1977.
23-42 FR 28137: June 2, 1977.
24-42 FR 28545: June 3, 1977.
25-42 FR 37373: July 21, 1977.
26-42 FR 40688: August 11, 1977.
27-42 FR 42353: August 23, 1977.
28-42 FR 45528: September 9, 1977.
29-42 FR 58755: November 11, 1977.
30-42 FR 60745: November 29, 1977.
31-43 FR 3715: January 27, 1978.
32-43 FR 4028: January 31, 1978.
33-43 FR 4621: February 3, 1978.
34-43 FR 6233: February 14, 1978.
35-43 FR 9612: March 9, 1978.
36-43 FR 12691: March 27, 1978.
37-43 FR 15429: April 13, 1978.
38-43 FR 16345: April 18, 1978.
40-43 FR 20504: May 12, 1978.
41-43 FR 28932: July 3, 1978.
42-43 FR 32808: July 28, 1978.
43-43 FR 34479: August 4, 1978.
45-44 FR 21289: April 10, 1979.
46-44 FR 23064: April 17, 1979.
48-44 FR 29480: May 21, 1979.
50-44 FR 37126: June 25, 1979.
51-44 FR 37132: June 25, 1979.
52-44 FR 42911: July 20, 1979.
54-44 FR 48220: August 21, 1979.
55-44 FR 54007: September 17, 1979.
60-44 FR 59084: October 12, 1979.
65-44 FR 69208: November 30, 1979.
66-44 FR 70677: December 7, 1979.
67-44 FR 75076: December 18, 1979.
82-45 FR 18010: March 20, 1980.
90-45 FR 21833: April 2, 1980.
91-45 FR 24090: April 8, 1980.
92-45 FR 27713: April 23, 1980.
93-45 FR 28722: April 30, 1980.
94-45 FR 35521: May 28, 1980.
95-45 FR 44935: July 2, 1980.
96-45 FR 44939: July 2, 1980.
97-45 FR 47352: July 14, 1980.
98-45 FR 47355: July 14, 1980.
99-45 FR 52803: August 8, 1980.
100-45 FR 52807: August 8, 1980.
102-45 FR 54678: August 15, 1980.
103-45 FR 55654: August 20, 1980.
105-45 FR 63812: September 25, 1980.
106-45 FR 65132: October 1, 1980.
108-46 FR 3178: January 13, 1981.
111-46 FR 11665: February 10, 1981.
112-46 FR 40025: August 8, 1981.
113-46 FR 40664: August 10, 1981.
114-47 FR 4204: January 28, 1982.
115-47 FR 5425: February 5, 1982.
117-47 FR 19995: May 10, 1982.
119-47 FR 31670: July 21, 1982.
123-47 FR 43701: October 4, 1982.
124-47 FR 43962: October 5, 1982.
125-47 FR 46093: October 15, 1982.
127-48 FR 612: January 5, 1983.
128-48 FR 1726: January 14, 1983.
129-48 FR 28464: June 22, 1983.
130-48 FR 40184: September 2, 1983.
131-48 FR 43043: September 21, 1983.
132-48 FR 46057: October 11, 1983.
134-48 FR 46336: October 12, 1983.
135-48 FR 46341: October 12, 1983.
136-48 FR 49249: October 25, 1983.
137-49 FR 1058: January 9, 1984.
138-49 FR 1994: January 17, 1984.
139-49 FR 2783: January 23, 1984.
142-49 FR 7335: February 28, 1984.
143-49 FR 7394: February 29, 1984.
144-49 FR 7398: February 29, 1984.
145-49 FR 10526: March 20, 1984.
146-49 FR 14356: April 11, 1984.
149-49 FR 22334: May 29, 1984.
150-49 FR 27514: July 5, 1984.
156-49 FR 33835: August 27, 1984.
157-49 FR 34494: August 31, 1984.
159-49 FR 34504: August 31, 1984.
160-49 FR 34510: August 31, 1984.
161-49 FR 35954: September 13, 1984.
163-49 FR 43069: October 26, 1984.
164-49 FR 43969: November 1, 1984.
166-49 FR 45163: November 15, 1984.
168-49 FR 49639: December 21, 1984.
169-50 FR 1056: January 9, 1985.
170-50 FR 4226: January 30, 1985.
171-50 FR 4945: February 4, 1985.
173-50 FR 12302: March 28, 1985.
174-50 FR 12305: March 28, 1985.
181-50 FR 20785: May 20, 1985.
182-50 FR 21792: May 28, 1985.
183-50 FR 23884: June 6, 1985.
184-50 FR 24530: June 11, 1985.
185-50 FR 24653: June 12, 1985.
186-50 FR 25678: June 20, 1985.
188-50 FR 26575: June 27, 1985.
189-50 FR 27002: July 1, 1985.
193-50 FR 30194: July 24, 1985.
195-50 FR 31596: August 5, 1985.
196-50 FR 31603: August 5, 1985.
203-50 FR 37198: September 12, 1985.
205-50 FR 39117: September 27, 1985.
206-50 FR 39123: September 27, 1985.
210-50 FR 50308: December 10, 1985.
211-50 FR 50733: December 11, 1985.
212-50 FR 51252: December 16, 1985.
216-51 FR 6690: February 25, 1986.
222-51 FR 10850: March 31, 1986.

§ 17.12

223—51 FR 10837; March 31, 1986.
224—51 FR 10864; March 31, 1986.
227—51 FR 16047; April 30, 1986.
228—51 FR 16482; May 2, 1986.
233—51 FR 17980; May 18, 1986.
236—51 FR 23781; July 1, 1986.
239—51 FR 27495; July 31, 1986.
241—51 FR 31422; September 3, 1986.
242—51 FR 34412; September 26, 1986.
246—51 FR 34425; September 26, 1986.

(48 FR 34182, July 27, 1983; 48 FR 34961, Aug. 2, 1983, as amended at 48 FR 39943, Sept. 2, 1983; 48 FR 46337, Oct. 12, 1983; 48 FR 52743, Nov. 22, 1983; 49 FR 1058, Jan. 9, 1984; 49 FR 33892, Aug. 27, 1984)

EDITORIAL NOTE For additional **FEDERAL REGISTER** citations affecting the table in § 17.11(h), see the listing which follows the table.

EFFECTIVE DATE NOTE At 51 FR 34412, 34425, Sept. 26, 1986, the table in § 17.11(h) was amended by adding "Shrew, Dismal Swamp southeastern" alphabetically under "Mammals" and adding "Crayfish, Nashville" alphabetically under "Crustaceans", effective October 27, 1986.

§ 17.12 Endangered and threatened plants.

(a) The list in this section contains the names of all species of plants which have been determined by the Services to be Endangered or Threatened. It also contains the names of species of plants treated as Endangered or Threatened because they are sufficiently similar in appearance to Endangered or Threatened species (see § 17.50 *et seq.*).

(b) The columns entitled "Scientific name" and "Common name" define the species of plant within the meaning of the Act. Although common names are included, they cannot be relied upon for identification of any specimen, since they may vary greatly in local usage. The Services shall use the most recently accepted scientific name. In cases in which confusion might arise, a synonym(s) will be provided in parentheses. The Services shall rely to the extent practicable on the *International Code of Botanical Nomenclature*.

(c) In the "Status" column the following symbols are used: "E" for Endangered, "T" for Threatened, and "E for T" (S/A) for similarity of appearance species.

(d) The other data in the list are nonregulatory in nature and are provided for the information of the

50 CFR Ch. I (10-1-86 Edition)

reader. In the annual revision and compilation of this title, the following information may be amended without public notice: the spelling of species' names, historical range, footnotes, references to certain other applicable portions of this title, synonyms, and more current names. In any of these revised entries, neither the species, as defined in paragraph (b) of this section, nor its status may be changed without following the procedures of Part 424 of this title.

(e) The "Historic range" indicates the known general distribution of the species or subspecies as reported in the current scientific literature. The present distribution may be greatly reduced from this historic range. This column does not imply any limitation on the application of the prohibitions in the Act or implementing rules. Such prohibitions apply to all individuals of the plant species, wherever found.

(f)(1) A footnote to the **FEDERAL REGISTER** publication(s) listing or reclassifying a species is indicated under the column "When listed." Footnote numbers to §§ 17.11 and 17.12 are in the same numerical sequence, since plants and animals may be listed in the same **FEDERAL REGISTER** document. That document, at least since 1973, includes a statement indicating the basis for the listing, as well as the effective date(s) of said listing.

(2) The "Special rules" and "Critical habitat" columns provide a cross reference to other sections in Parts 17, 222, 226, or 227. The "Special rules" column will also be used to cite the special rules which describe experimental populations and determine if they are essential or nonessential. Separate listings will be made for experimental populations, and the status column will include the following symbols: "XE" for an essential experimental population and "XN" for a nonessential experimental population. The term "NA" (not applicable) appearing in either of these two columns indicates that there are no special rules and/or critical habitat for that particular species. However, all other appropriate rules in Parts 17, 217 through 227, and 402 still apply to that species. In addition, there may be other rules in this title that relate to

U.S. Fish

such plan-
ments. It
erences in
list all the
ices which
or to the

such plants, e.g., port-of-entry requirements. It is not intended that the references in the "Special rules" column list all the regulations of the two Services which might apply to the species or to the regulations of other Federal

agencies or State or local governments.

(g) The listing of a particular taxon includes all lower taxonomic units (see § 17.11(g) for examples).

(h) The "List of Endangered and Threatened Plants" is provided below:

[illegible]

Berberidaceae—Barberry family:
Mahonia saccata (= Berberis s.)

Betulaceae—Birch family:
Betula uber

Round leaf birch

U.S.A. (VA)

E 38 NA NA

Boraginaceae—Borage family:
Anisochloa grandiflora

Brassicaceae—Mustard family:

Arabis modonensis
Erysimum capitatum var. angustatum
Thelypodium stenopetalum

Burseraceae—Burwood family:
Bursera velut

Cactaceae—Cactus family:

Ancistrocactus lobuchii (= Echinocactus l., Mammillaria l.)

Cereus eriophorus var. fragrans

Cereus rostratus

Coryphantha minima (= C. nelsonii, Escobaria s., Mammillaria n.)

Coryphantha ramulosa

Coryphantha robinsonii (= Cochisea l., Escobaria r.)

Coryphantha sneedi var. leei (= Escobaria l., Mammillaria l.)

Coryphantha sneedi var. sneedi (= Escobaria s., Mammillaria s.)

Echinocactus horizontalis var. nicholii

Echinocereus engelmannii var. purpureus

Echinocereus fendleri var. kuenzleri (= E. kuenzleri, E. hampelii of authors, not Fobes)

Echinocereus lloydii (= E. rostratus var. l.)

Echinocereus reichenbachii var. albertii (= E. melanocentrus)

Echinocereus triglochidatus var. arizonicus (= E. arizonicus)

Echinocereus triglochidatus var. inermis (= E. coccineus var. l., E. phoeniceus var. l.)

Echinocereus viridiflorus var. davisi (= E. davisi)

Neobryonia marposensis (= Echinocactus m., Echinomastus m.)

Pediocactus bradyi (= Toumeyia b.)

Pediocactus knowltonii (= P. bradyi var. k. Toumeyia k.)

Pediocactus peeblesianus var. peeblesianus (= Echinocactus p., Navajo p., Toumeyia p., Utahia p.)

Pediocactus silius (= Echinocactus s., Utahia s.)

Sclerocactus glaucus (= Echinocactus g., E. subglaucus, E. whipplei var. g., Pediocactus g., S. franklinii, S. whipplei var. g.)

Sclerocactus mesquedae (= Colorado m., Echinocactus m., Pediocactus m.)

Sclerocactus virgatus (= Pediocactus v.)

Caryophyllaceae—Pink family:

Schizaea adnata

Large-flowered flaxseed

U.S.A. (CA)

E 176 17.96(a)

NA

McDonald's rock-rose

U.S.A. (CA)

E 44

NA

NA

Contra Costa wallflower

do

E 38

17.96(a)

NA

Slender-petaled mustard

do

E 158

NA

NA

Vahl's borwood

U.S.A. (PR)

E 197

NA

NA

Tobusch fishhook cactus

U.S.A. (TX)

E 80

NA

NA

Fragrant prickly-apple

U.S.A. (FL)

E 208

NA

NA

Key tree-cactus

U.S.A. (FL), Cuba

E 153

NA

NA

Nella cory cactus

U.S.A. (TX)

E 81

NA

NA

Bunched cory cactus

U.S.A. (TX), Mexico

T 77

NA

NA

(Coahuila)

Cochisea pincushion cactus

U.S.A. (AZ), Mexico

T 214

NA

NA

(Sonora)

Lee pincushion cactus

U.S.A. (NM)

T 81

NA

NA

Sneed pincushion cactus

U.S.A. (TX, NM)

E 82

NA

NA

Nichol's Turk's head cactus

U.S.A. (AZ)

E 71

NA

NA

Purple-spined hedgehog cactus

U.S.A. (UT)

E 58

NA

NA

Kuenzler hedgehog cactus

U.S.A. (NM)

E 70

NA

NA

Lloyd's hedgehog cactus

U.S.A. (TX)

E 87

NA

NA

Black lece cactus

do

E 68

NA

NA

Arizona hedgehog cactus

U.S.A. (AZ)

E 82

NA

NA

Spineless hedgehog cactus

U.S.A. (CO, UT)

E 83

NA

NA

Davis' green pithays

U.S.A. (TX)

E 81

NA

NA

Lloyd's Marposse cactus

U.S.A. (TX), Mexico

T 77

NA

NA

(Coahuila)

Bredy pincushion cactus

U.S.A. (AZ)

E 83

NA

NA

Knowlton cactus

U.S.A. (NM, CO)

E 72

NA

NA

Peebles Navajo cactus

U.S.A. (AZ)

E 69

NA

NA

Siler pincushion cactus

U.S.A. (AZ, UT)

E 84

NA

NA

Uta Basin hookless cactus

U.S.A. (CO, UT)

T 58

NA

NA

Mesa Verde cactus

U.S.A. (CO, NM)

T 75

NA

NA

Wright fishhook cactus

U.S.A. (UT)

E 58

NA

NA

Diamond Head schizodes

U.S.A. (HI)

E 141

NA

NA

U.S. Fish and Wildlife Serv., Interior

§ 17.12

Species		Historic range	Sta- tus	When listed	Critical habitat	Special rules
Scientific name	Common name					
Chenopodiaceae—Goosefoot family: <i>Atriplex mohaveana</i>	Amargosa nitewort.....	U.S.A. (CA).....	E	181	17.96(a)	NA
Cistaceae—Rockrose family: <i>Hudsonia montana</i>	Mountain golden heather.....	U.S.A. (NC).....	T	107	17.96(a)	NA
Crassulaceae—Stonecrop family: <i>Dudleya traskiae</i>	Santa Barbara Island liveforever.....	U.S.A. (CA).....	E	36	NA	NA
Cucurbitaceae—Gourd family: <i>Tumamoca macdougalii</i>	Tumamoc globe-berry.....	U.S.A. (AZ), Mexico (Sonora).....	E	226	NA	NA
Cupressaceae—Cypress family: <i>Fitzroya cupressoides</i>	Chilean false larch (= alerce).....	Chile, Argentina.....	T	78	NA	NA
Cyperaceae—Sedge family: <i>Carex speculicola</i>	None.....	U.S.A. (AZ).....	T	178	17.96(a)	NA
Ericaceae—Heath family: <i>Arctostaphylos pungens</i> var. <i>ravenii</i> (= <i>A. hookeri</i> ssp. <i>ravenii</i>).....	Presidio (= Raven's) manzanita.....	U.S.A. (CA).....	E	65	NA	NA
<i>Rhododendron chapmanii</i>	Chapman rhododendron.....	U.S.A. (FL).....	E	47	NA	NA
Euphorbiaceae—Spurge family: <i>Euphorbia</i> (= <i>Chamaesyce</i>) <i>deltoidea</i> ssp. <i>deltoidea</i>	Spurge.....	U.S.A. (FL).....	E	182	NA	NA
<i>Euphorbia</i> (= <i>Chamaesyce</i>) <i>garberi</i>	None.....	do.....	T	182	NA	NA
<i>Euphorbia skottsbergii</i> var. <i>kalsbeardi</i>	Ewa Plains "akoko".....	U.S.A. (HI).....	E	120	NA	NA
<i>Jatropha costaricensis</i>	Costa Rican jatropha.....	Costa Rica.....	E	154	NA	NA
Fabaceae—Pee family: <i>Arorpha granulata</i>	Crenulate lead-plant.....	U.S.A. (FL).....	E	182	NA	NA
<i>Astragalus humilimus</i>	Mancoas milk-velch.....	U.S.A. (CO, NM).....	E	187	NA	NA
<i>Astragalus perianus</i>	Rydburg milk-velch.....	U.S.A. (UT).....	T	39	NA	NA
<i>Astragalus phoenix</i>	Ash Meadows milk-velch.....	U.S.A. (NV).....	T	181	17.96(a)	NA
<i>Baptisia arachnifera</i>	Hairy rattlesnake.....	U.S.A. (GA).....	E	39	NA	NA
<i>Galactia amellii</i>	Small's milk-pee.....	U.S.A. (FL).....	E	182	NA	NA
<i>Hoffmannseggia tenella</i>	Slender rush-pee.....	U.S.A. (TX).....	E	209	NA	NA
<i>Lotus dendroideus</i> ssp. <i>traskiae</i> (= <i>L. scoparius</i> ssp. <i>t.</i>).....	San Clemente Island broom.....	U.S.A. (CA).....	E	26	NA	NA
<i>Mezoneuron levalense</i>	Uhiuhi.....	U.S.A. (HI).....	E	238	NA	NA
<i>Vicia manzanilii</i>	Hawallen velch.....	do.....	E	39	NA	NA
Frankeniaceae—Frankenia family: <i>Frankenia johnstonii</i>	Johnston's frankenia.....	U.S.A. (TX), Mexico (Nuevo Leon).....	E	155	NA	NA

§ 17.12

50 CFR Ch. I (10-1-86 Edition)

Gentianaceae—Gentian family: <i>Centaurium hemophilum</i>	Spring-icing centaury.....	U.S.A. (CA, NY).....	T	181	17.96(a)	NA
Goodeniaceae—Goodenia family: <i>Scaevola coriacea</i>	Dwarf naupaka.....	U.S.A. (HI).....	E	231	NA	NA
Hydrophyllaceae—Waterleaf family: <i>Phacelia argillacea</i>	Clay phacelia.....	U.S.A. (UT).....	E	44	NA	NA
<i>Phacelia formosula</i>	North Park phacelia.....	U.S.A. (CO).....	E	121	NA	NA
Lamiaceae—Mint family:						

U.S. Fish and Wild

Vicia menziesii
 Frankeniaceae—Frankenia family:
 Frankenia johnstonii

Johnst

Marie

9443218 0516
 U.S.A. (CA, HI, CO, NM, AZ, NV)
 (Hawaii 1904)

E

166

NA

NA

ition)

103

Goodeniaceae—Goodenia family: Dontostemon nemophilum	Spring-living centaury	U.S.A. (CA, NV)	T	181	17.96(a)	NA	NA
Goodeniaceae—Goodenia family: Scaevola canescens	Dwarf naupaka	U.S.A. (HI)	E	231	NA	NA	NA
Hydrophyllaceae—Waterleaf family: Phacelia argylea	Clay phacelia	U.S.A. (UT)	E	44	NA	NA	NA
Phacelia formosula	North Park phacelia	U.S.A. (CO)	E	121	NA	NA	NA
Lamiaceae—Mint family: Acanthomintha obovata ssp. duttonii	San Mateo thornmint	U.S.A. (CA)	E	204	NA	NA	NA
Dicerandra comutissima	Longspurred mint	U.S.A. (FL)	E	207	NA	NA	NA
Dicerandra tridactyla	Scrub mint	do	E	207	NA	NA	NA
Dicerandra immaculata	Lakela's mint	do	E	180	NA	NA	NA
Haplostachys haplostachys var. angustifolia	None	U.S.A. (HI)	E	73	NA	NA	NA
Hedeoma apiculatum	McKinnis pennyroyal	U.S.A. (TX, NM)	T	118	17.96(a)	NA	NA
Hedeoma tomentosum	Todesen's pennyroyal	U.S.A. (NM)	E	110, 112	17.96(a)	NA	NA
Pogogyne abramis	San Diego mesa mint	U.S.A. (CA)	E	44	NA	NA	NA
Scutellaria montana	Large-flowered skullcap	U.S.A. (GA, TN)	E	234	NA	NA	NA
Stenogyne angustifolia var. angustifolia	None	U.S.A. (HI)	E	73	NA	NA	NA
Lauraceae—Laurel family: Lindera melissifolia	Pondberry	U.S.A. (AL, AR, FL, GA, LA, MO, MS, NC, SC)	E	240	NA	NA	NA
Liliaceae—Lily family: Erythronium propitans	Minnesota trout lily	U.S.A. (MN)	E	221	NA	NA	NA
Harporocallis fleve	Harper's beauty	U.S.A. (FL)	E	67	NA	NA	NA
Tritium persistens	Persistent trillium	U.S.A. (GA, SC)	E	39	NA	NA	NA
Loasaceae—Loasa family: Mentzelia leucophylla	Ash Meadows blazing star	U.S.A. (NV)	T	181	17.96(a)	NA	NA
Malvaceae—Mallow family: Abutilon menziesii	Ko'oke's mallow	U.S.A. (HI)	E	243	NA	NA	NA
Callitriche acutifolia	Texas poppy-mallow	U.S.A. (TX)	E	109, 112	NA	NA	NA
Hibiscadelphus distans	Kauai hau kushui	U.S.A. (HI)	E	225	NA	NA	NA
Mimna coral	Peter's Mountain mallow	U.S.A. (VA)	E	230	NA	NA	NA
Kokia cookii	Cooke's kokia	U.S.A. (HI)	E	74	NA	NA	NA
Kokia drynarioides	Ko'ke's (=hau-hale'ule or Hawaii tree cotton)	do	E	187	17.96(a)	NA	NA
Melastomaceae—Clematis family: Sidaea pedata	San Clemente Island bush-mallow	U.S.A. (CA)	E	26	NA	NA	NA
	Pedate checker-mallow	do	E	158	NA	NA	NA
Nyctaginaceae—Four-o'clock family: Mirabilis maculata	MacFarlane's four-o'clock	U.S.A. (ID, OR)	E	66	NA	NA	NA

U.S. Fish and Wildlife Serv., Interior

\$ 17.12

Species	Scientific name	Common name	Historic range	Sta- tus	When listed	Critical habitat	Special rules										
Onagraceae—Evening primrose family:	<i>Carrionia barkhousii</i>		USA (CA)	T	172	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Demissa arvensis</i>		do	E	38	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Onoclea delicata</i> ssp. <i>howellii</i>		do	E	38	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Orchidaceae—Orchid family:																
Papaveraceae—Poppy family:	<i>Isotria medeoloides</i>		USA (CT, L. MA, MD, ME, MI, MO, NC, NH, NJ, NY, PA, RI, SC, VA, VT), Canada	E	122	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Spiranthes perfoliata</i>		USA (MD)	E	118	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Argemone humilis</i>	Dwarf bear-poppy	USA (NM)	E	78	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Prunaceae—Pine family:																
Rosaceae—Rose family:	<i>Abies guatemalensis</i>		Honduras, Guatemala	T	84	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Guatemelia</i> fr. (= <i>prunella</i>)																
	<i>Botano grass</i>		USA (CA)	E	44	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Carter's panicum</i>		USA (CA)	E	123	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Poaceae—Grass family:	<i>Triticum monococcum</i> (= <i>Orville m.</i>)		USA (CA)	E	123	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Panicum carteri</i>		USA (CA)	E	38	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Syntherisma alexandrina</i>		USA (TX)	E	38	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Zizania texana</i>	Texas wild-rice	USA (TX)	E	38	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Polygalaceae—Milkwort family:	<i>Polygala eriotheca</i>		USA (TX)	E	192	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Polygonaceae—Buckwheat family:																
	<i>Eriogonum ovalifolium</i> var. <i>williamsii</i>		USA (NM)	T	110, 112	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Eriogonum pectinatum</i>		USA (NM)	E	237	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Primulaceae—Primrose family:	<i>Primula megarhiza</i>		USA (NM)	E	181	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Clay-loving wild-buckwheat</i>		USA (NM)	E	181	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Magick primrose</i>		USA (NM)	T	190	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Ranunculaceae—Buttercup family:																
Ranunculaceae—Buttercup family:	<i>Acronium novaeboracense</i>		USA (MA, NY, OH, WA)	T	38	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Clanetia socalis</i>		USA (AL)	E	248	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Delphinium albertense</i>		USA (CA)	E	28	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>San Clemente island larkspur</i>		USA (CA)	E	28	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rubiaceae—Rubiaceae family:	<i>Zanthoxylum thomasi</i>		USA (PR, VA)	E	213	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>St. Thomas prickly-ash</i>		USA (PR, VA)	E	213	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Guarea bryonia</i>		USA (PR)	E	188	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Polanisia robbinsii</i>		USA (PR, VT)	E	104	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rosaceae—Rose family:	<i>Covillea rubriflora</i>		USA (AZ)	E	148	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Arctostaphylos</i>		USA (AZ)	E	181	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Ash Meadows</i>		USA (AZ)	E	181	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<i>Robbins' chrysothamnus</i>		USA (AZ, VT)	E	181	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

§ 17.12

U.S. Fish and Wildlife Serv., Interior

148	NA	U.S. (AZ)	Arizona cottonwood	E	148	NA	Rosaceae—Rose family:
181	17.8(a)	U.S.A. (NV)	Asi. bloodroot leaves	T	181	17.8(a)	U.S.A. (NV)
104	17.8(a)	U.S.A. (MT, VT)	Rocky mtn. cinquefoil	E	104	17.8(a)	Potentilla rostrata
198	NA	U.S.A. (W)	Na'u (Hawaiian gardenia)	E	198	NA	Rubiaceae—Coffee family:
210	NA	U.S.A. (PR, VI)	St. Thomas prickly ash	E	210	NA	Gardenia brighamii
215	NA	U.S.A. (HI)	Lani sandalwood or black	E	215	NA	Rubiaceae—Sandalwood family:
58.88	NA	U.S.A. (AL, GA, TN)	Green pitcher plant	E	58.88	NA	Sarracenia purpurea
150	NA	U.S.A. (FL, SC)	Miconia gooseneck	T	150	NA	Sarracenia purpurea
28	NA	U.S.A. (CA)	San Clemente Island Indian paintbrush	E	28	NA	Scrophulariaceae—Snapdragon family:
44	NA	U.S.A. (CA), Mexico	Salt marsh bird's-beak	E	44	NA	Cassia greggii
235	NA	U.S.A. (CA)	Palmdale-traced bird's-beak	E	235	NA	Coryphantha maritima ssp. maritima
30	NA	U.S.A. (ME), Canada	Furber's lousewort	E	30	NA	Coryphantha maritima
176	NA	U.S.A. (PR)	Beakbird goatee, malarkey	E	176	NA	Balanaceae—Myrsinaceae family:
182	NA	U.S.A. (TX)	Texas snowflake	E	182	NA	Gouania elagans
140	NA	U.S.A. (FL, GA)	Florida tonyia	E	140	NA	Syracaceae—Syrac family:
							Syrax lucida
							Taxaceae—Yew family:
							Taxus canadensis

EDITORIAL NOTE: For "When listed" citations, see list following for symbols in "When listed" see below:
E—Indicates Emergency rule publication (see FR document for effective dates); subsequent number(s) indicate FR final rule, if applicable under "When listed".

U.S. Fish and Wildlife Serv., Interior

[illegible]

EDITORIAL NOTE: For "When Based" citations, see the following: for articles in "When Based" see below; C indicates Emergency rule publication (see FBI document for effective date); subsequent number(s) indicate FBI final rule. If applicable under "When Based"

REFERENCE 20

Memo to file from KH Cramer regarding Personal Communication
with M Gillum concerning Richland City Well Data, August 6, 1987

9443218.0020

FILE NOTE

Date: 12/23/87

By: R.D. Stenner *R.D. Stenner*

Re: Telephone conversation with Michael Gillum, City of Richland,
Regarding Kennewick Intertie on the Richland Water System.

The Kennewick intertie on the Richland water system is an intertie that services both ways (i.e., Richland can receive water from Kennewick and Kennewick can receive water from Richland).

The Kennewick system would not have the capacity to service the Richland system as an alternate water supply. Michael said that the Kennewick intertie is only used during problems with the system during peak irrigation demand periods, and that the Kennewick system would not have the capacity to serve the Richland system should something happen to cause the Richland water system to be inoperative.

The 300 Area intertie is a one-way only intertie for the 300 Area to receive water from Richland. The Richland system can not receive water from the 300 Area intertie.

MEMO: To File

DATE: 8/6/87

FROM: K. H. Cramer

SUBJECT: Personal conversation with Michael Gillum
Regard Richland City Recharge Wells and Water Supply System

250782616

There are 14 recharge wells that are within 3 miles of the Hanford Site boundary. These wells have depths that range from 40 to 134 feet. The recharge well system is part of the city's overall water supply system. The recharge wells are designed to be used in conjunction with the Water Supply holding ponds located beside the wells. The recharge well system is used during peak water demand periods and when the Columbia River Water Pump System is down for maintenance. The recharge system operates with water being pumped to the holding ponds from the Columbia River. The water in the ponds then seeps through the soil to the aquifer where it is pumped by the recharge wells to the city's water supply system. The recharge wells are tied into the overall water supply system, which means that the water from the wells is mixed with the Columbia River water and distributed throughout the city.



503 343 3151

MICHAEL GILLUM

Associate Engineer
Utility Administration Division
Water & Waste Utilities Department

125 SWIFT BOULEVARD BOX 110 RICHLAND WASHINGTON 99352

Ref. 20.1

CITY OF RICHLAND

WATER SYSTEM DATA

A. PRODUCTION

The City of Richland's water supply comes from two major sources:

1. Water Treatment Plant: The Water Treatment Plant uses the "Micro-Floc" process for water treatment (see attached flow diagram). Its present design production capacity is 30 million gallons per day. The plant can be expanded to a maximum production capacity of 45 MGD.
2. Wells: The 18 wells are located in five well fields. The total production capacity of all the wells is 18.2 MGD. The North Richland well field groundwater is recharged artificially through the use of recharge basins (see attachment). The wells are recharged through the months of April to November.

The production capacities can be summarized as follows:

<u>Source</u>	<u># Wells</u>	<u>Capacity</u>
Columbia Well Field	1	0.8 MGD
Duke Well Field	2	2.0 MGD
North Richland Well Field & D-5	11	11.0 MGD
Wellisian Way Well Field	3	3.0 MGD
Willowbrook Well	1	1.4 MGD
Water Treatment Plant		30.0 MGD
TOTAL	18	48.2 MGD

B. STORAGE

The City of Richland's water system has a water storage capacity of 23.67 million gallons. The major elevated storage, a five and ten million gallon reservoir, is located west of the Yakima River. The other elevated storage consists of five additional reservoirs, with a capacity of 4.47 million gallons and are also located west of the Yakima River, serving the Badger Mountain Area. Water from the remaining reservoirs is pumped into the system by booster pumps.

Storage can be summarized as follows:

<u>Storage</u>	<u>Capacity</u>	
Two (2) one-million gallon reservoirs (1182)	2.0 MG	
Five million gallon reservoir	5.0 MG	
Ten million gallon reservoir	10.0 MG	
Water Treatment Plant Clearwell reservoir	2.2 MG	
Tapteal I reservoir (reservoir #1)	0.75 MG	
Tapteal I reservoir (reservoir #2)	2.6 MG	
Tapteal II reservoir (reservoir #1)	Upper Pressure Zone	0.18 MG
Tapteal II reservoir (reservoir #2)		0.7 MG
Country Ridge reservoir		0.24 MG
TOTAL		23.67 MG

C. TRANSMISSION

All water transmission lines, 10" or larger, are shown on the utility map of the City of Richland. The major transmission lines are shown on the attached facilities location map.

D. PRESSURE ZONES

The City of Richland has three pressure zones:

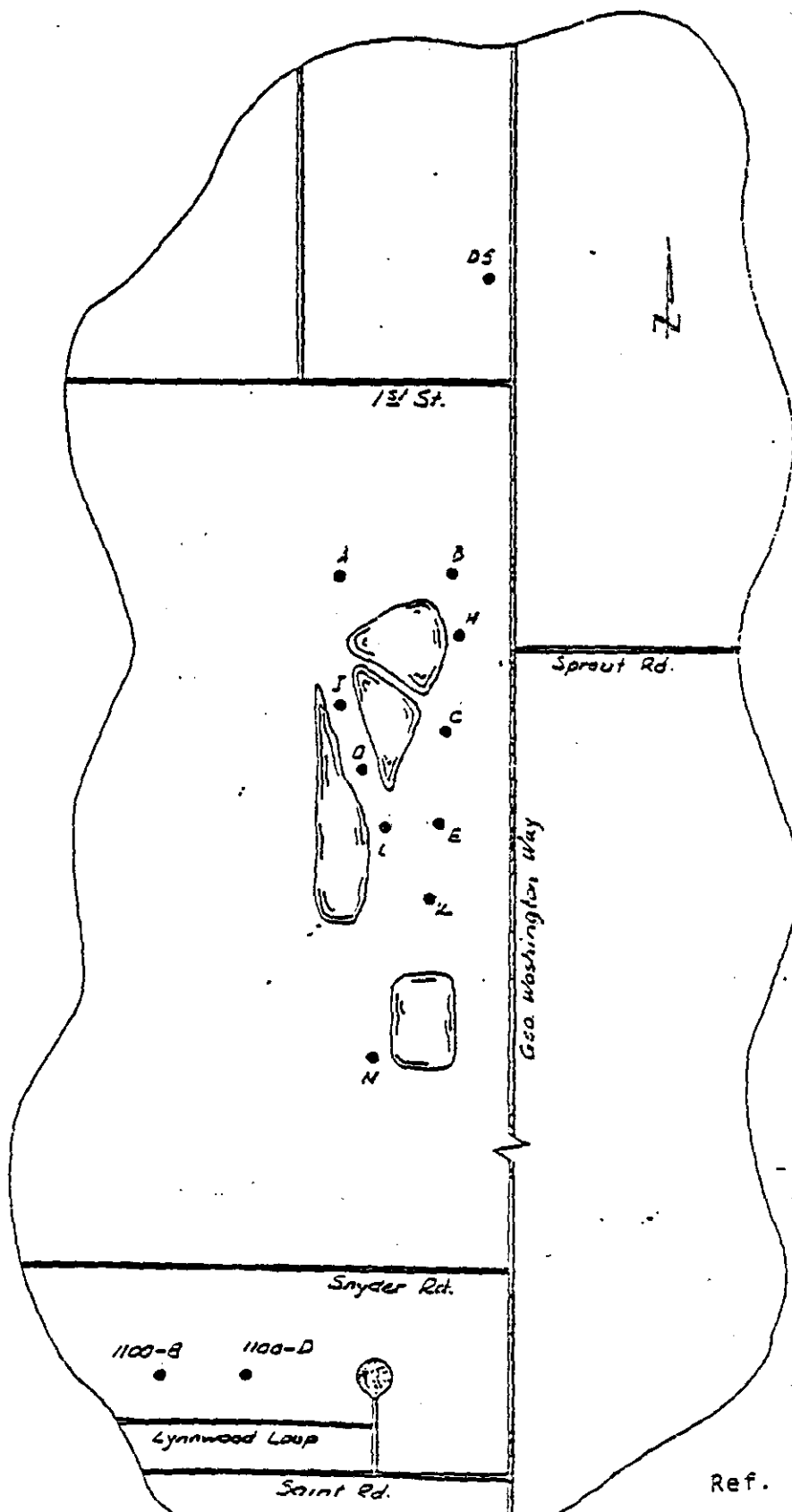
1. Richland City core area.
2. Badger Mountain/Meadow Springs area (area west of Yakima River) - Tapteal I pressure zone.
3. Badger Mountain/Meadow Springs area (higher elevations west of Keene Road and portion of Hills West area) - Tapteal II pressure zone.

The Badger Mountain/Meadow Springs area water is pumped from the Richland City core pressure zone to the higher Badger Mountain pressure zone. The booster pump station for this zone is located at the five and ten million gallon reservoirs.

The third pressure zone is supplied by (1) a pumping station off High Meadows Street and currently serves the majority of homes on High Meadows Street, Hillview Drive and all homes west of Orchard Court on Orchard Way and Greenview Drive, and (2) a pumping station on Keene Road at Country Ridge and serves the Country Ridge/Keene Village area.

NORTH RICHLAND WELLSNorth Richland Well Field

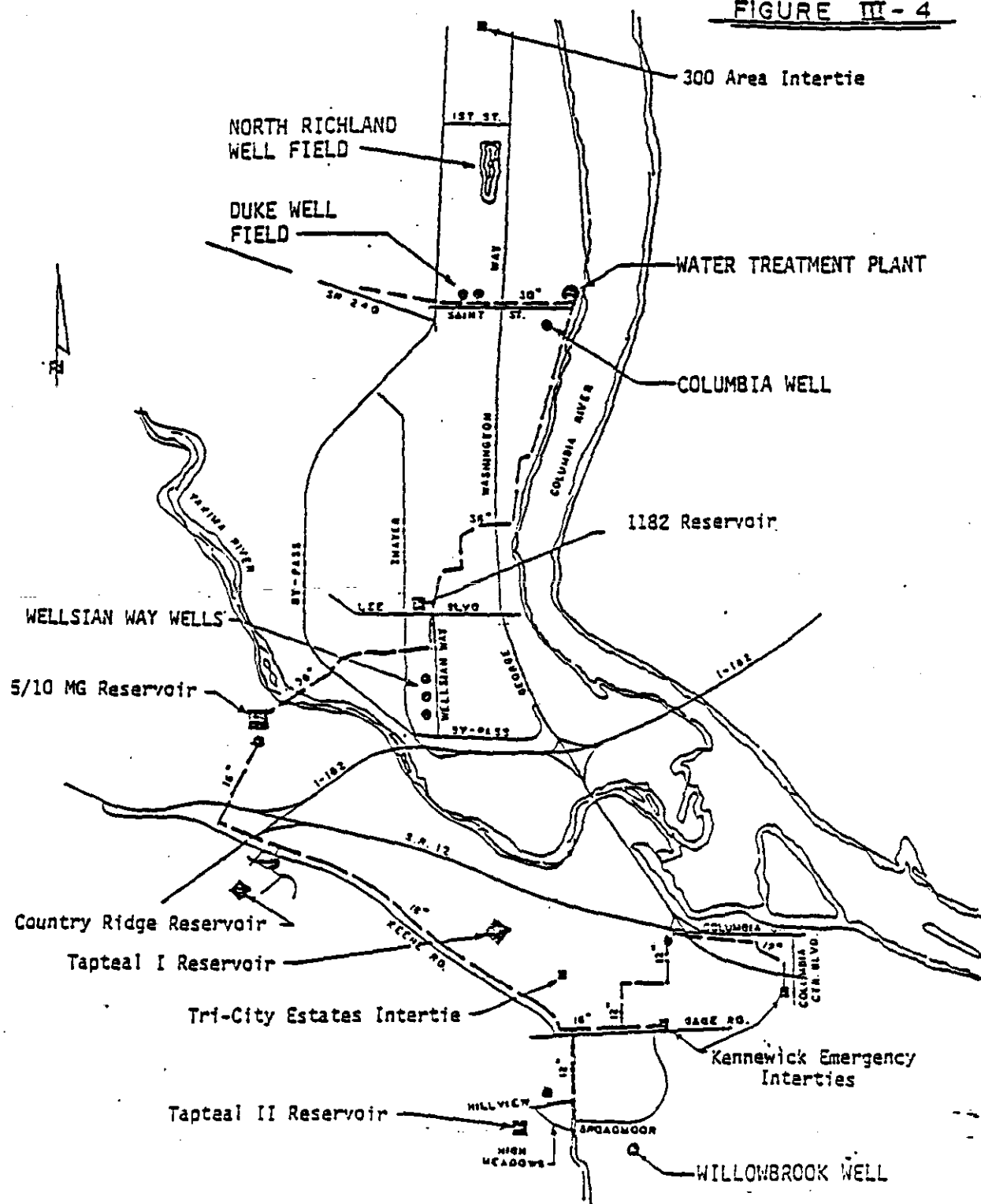
<u>Well #</u>	<u>Depth</u>
3000-A	88'
3000-B	87'
3000-C	64'
3000-D	75.3'
3000-E	61.8'
3000-H	56'
3000-J	71'
3000-K	59'
3000-L	83'
3000-N	40'
3000-DS	134'

Duke Well Field

<u>Well #</u>	<u>Depth</u>
1100-B	120'
1100-D	86'
1100-O	

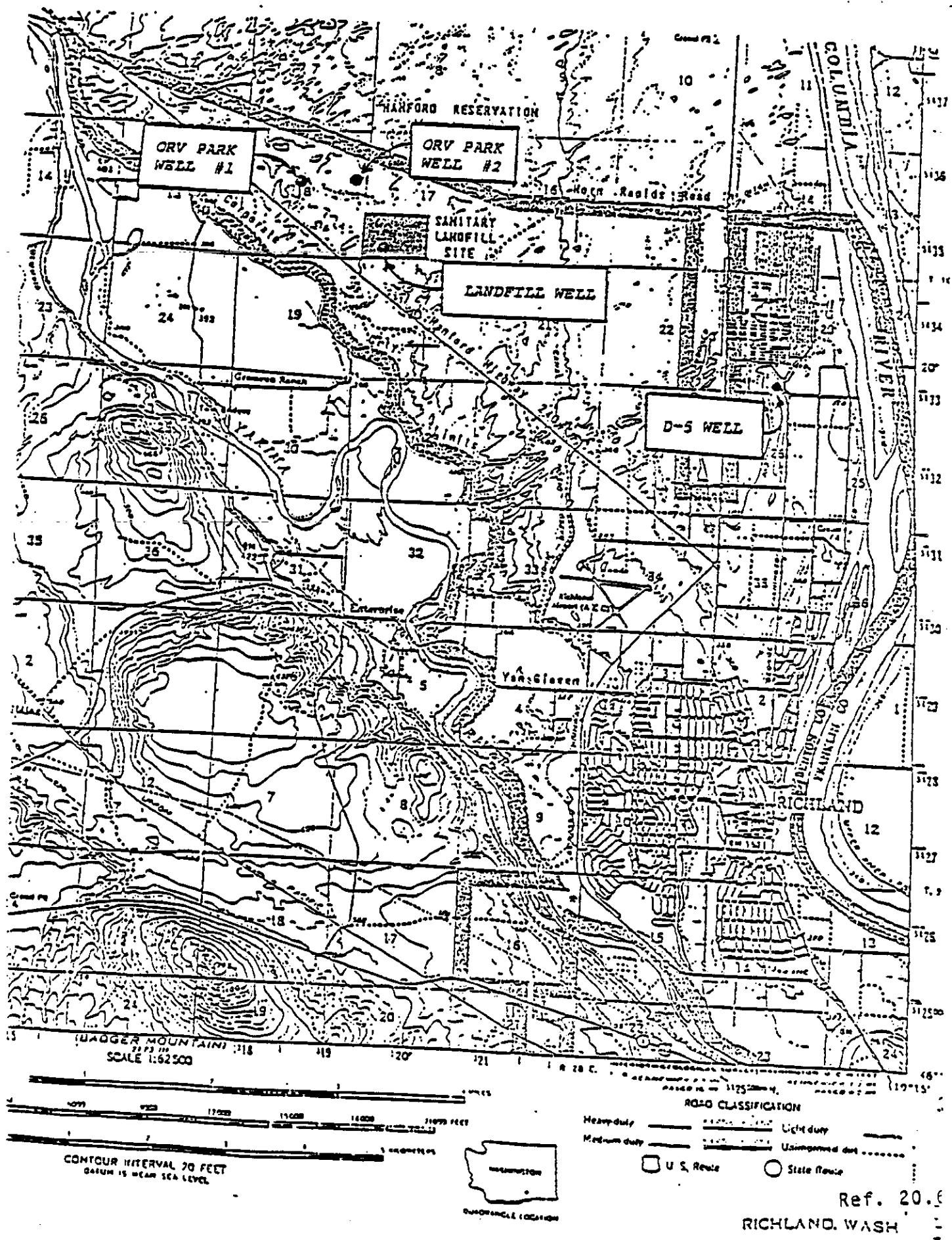
943218-0526

FIGURE III-4



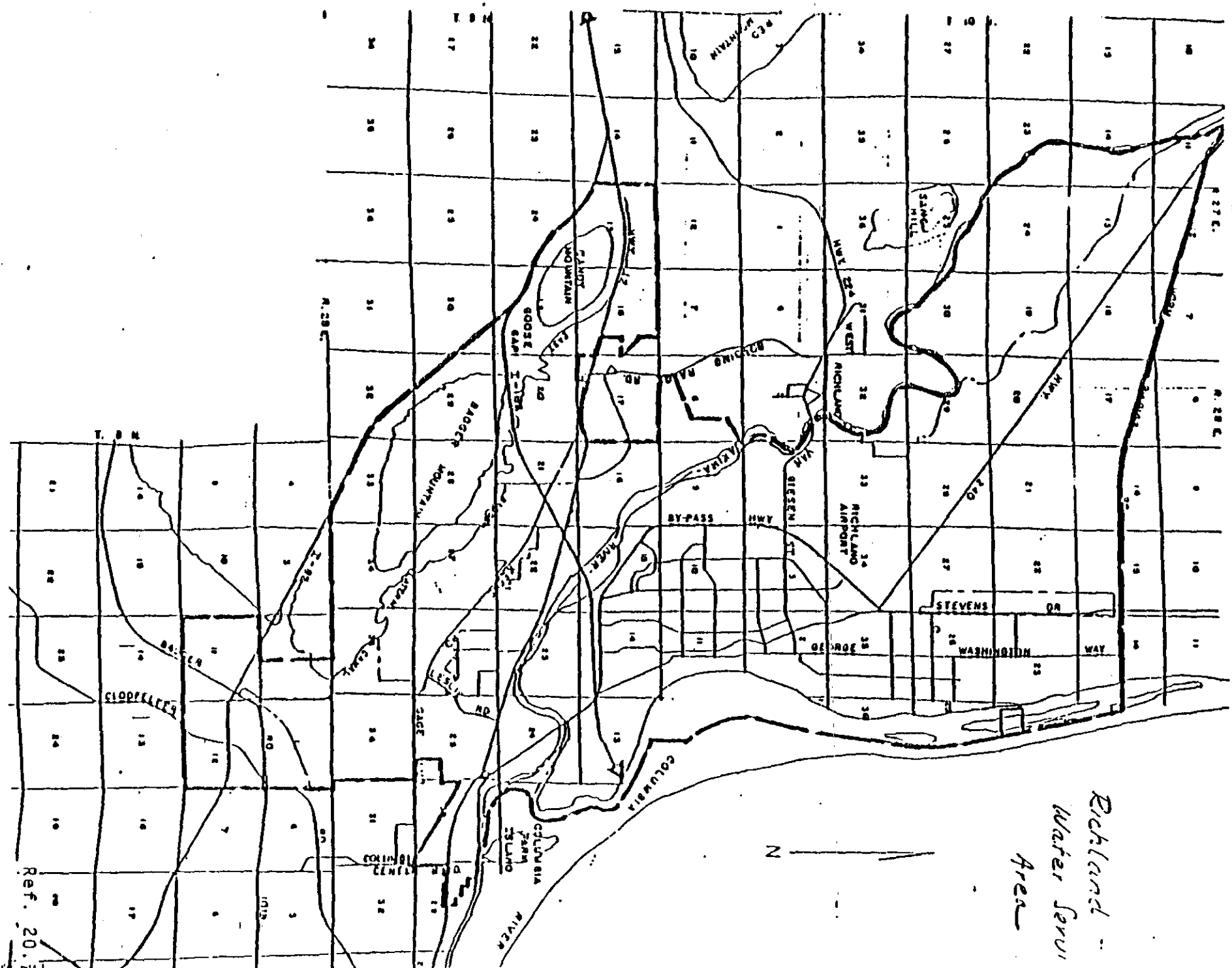
CITY OF RICHLAND
WATER SYSTEM SOURCE and STORAGE FACILITIES
LOCATION MAP

293.912416



Ref. 20.6

RICHLAND, WASH



Richland
Water Servi
Area

REFERENCE 21

Draft Phase I Installation Assessment of Inactive Waste-Disposal
Sites at Hanford, Volume 2 (HISS Database)

02000263

SITE ID NO.: 216-N-1

ALIAS: 212-N Swamp, 216-N-1 Swamp, 216-N-1 Covered Pond

STATUS: Inactive

DIMENSIONS:

Length: 500 ft

Width: 100 ft

Depth: 3 ft

Diameter: 0 ft

FACILITY: Pond

ELEVATION: 567 ft

WATERTABLE: 162 ft

LOCATION: 200 North

COORDINATES: Head: N53700/W65050 End: N54125/W65475

SITE DESCRIPTION:

Pond, measuring 500 ft. long x 100 ft. wide.

SERVICE DATES: 1944-1952

SERVICE HISTORY:

From 1944 to 1952 the site received the basin overflow from the 212-N building. The site was retired in 1952.

REFERENCES:

Documents: ARH-2806, RHO-CD-673, HW-55176

Photographs: 122440-29-CN

Drawings: H-3-57210

SITE ID NO.: 216-N-1

CHEMICALS DISPOSED

TOTAL VOLUME DISPOSED: 946000000 Liters

No chemicals discharged.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

Although used for radioactive waste disposal, no inventory is available.

These values are decayed through April 1, 1986.

SITE ID NO.: 216-N-2

ALIAS: 216-N-1 Trench, 216-N-2 Trench

STATUS: Inactive

DIMENSIONS:

Length: 50 ft

Width: 10 ft

Depth: 7 ft

Diameter: 0 ft

FACILITY: Crib

ELEVATION: 578 ft

WATERTABLE: 173 ft

LOCATION: 200 North

COORDINATES: N55485/W65788 (Center of crib)

SITE DESCRIPTION:

Trench, measuring 50 ft. long x 10 ft. wide (bottom dimensions), with a depth of 7 ft.

SERVICE DATES: 1947-1947

SERVICE HISTORY:

From 3/47 to 4/47 the site received the basin water and sludge cleanout when it was drained for special tests. The site was retired in 4/47 and the trench backfilled. The waste type is low activity.

REFERENCES:

Documents: ARH-2806, RHO-CD-673, HW-55176

Photographs: 122440-30-CN

Drawings: H-3-57210

SITE ID NO.: 216-N-2

CHEMICALS DISPOSED

TOTAL VOLUME DISPOSED: 7570000 Liters

No chemicals discharged.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.07540	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.31600
CS-137:	0.08560	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

These values are decayed through April 1, 1986.

SITE ID NO.: 216-N-3

ALIAS: 212-N-2 Trench, 212-N-3 Trench

STATUS: Inactive

DIMENSIONS:

Length: 50 ft

Width: 20 ft

Depth: 6 ft

Diameter: 0 ft

FACILITY: Crib

ELEVATION: 578 ft

WATERTABLE: 173 ft

LOCATION: 200 North

COORDINATES: N55455/W65838 (Center of crib)

SITE DESCRIPTION:

Trench, with 50 ft. long x 20 ft. wide bottom dimensions, with a depth of 6 ft.

SERVICE DATES: 1952-1952

SERVICE HISTORY:

From 5/52 to 6/52 the site received basin water and sludge cleanout from the 212-N building when the area was shut down. The site was retired in 6/52.

REFERENCES:

Documents: ARH-2806, RHO-CD-673, HW-55176

Photographs: 122440-30-CN

Drawings: H-3-57210

SITE ID NO.: 216-N-3

CHEMICALS DISPOSED

TOTAL VOLUME DISPOSED:

7570000 Liters

No chemicals discharged.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
NM-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.08520	NF-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TR-232:	0.00000
CS-134:	0.00000	BETA:	0.35600
CS-137:	0.09600	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

These values are decayed through April 1, 1986.

SITE ID NO.: 216-N-4

ALIAS: 212-P Swamp, 216-N-2, 216-N-4 Swamp
STATUS: Inactive
DIMENSIONS:

Length: 500 ft
Width: 200 ft
Depth: 3 ft
Diameter: 0 ft

FACILITY: Pond
ELEVATION: 558 ft
WATERTABLE: 153 ft

LOCATION: 200 North
COORDINATES: Head: N53400/W62600, End: N54300/W62700

SITE DESCRIPTION:

Pond, with 500 ft. x 200 ft. wide bottom dimensions.

SERVICE DATES: 1944-1952

SERVICE HISTORY:

From 9/44 to 6/52 the site received the basin overflow waste from the 212-P Building. The site was retired in 6/52 when the 212-P building was shut down.

REFERENCES:

Documents: ARH-2806, RHO-CD-673, HW-55176
Photographs: 122440-27-CN
Drawings: H-3-57210

SITE ID NO.: 216-N-4

CHEMICALS DISPOSED

TOTAL VOLUME DISPOSED: 946000000 Liters

No chemicals discharged.

RADIOISOTOPE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.07830	NF-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.05710
ZR-95:	0.00000	PU-240:	0.01540
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00152
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.31400
CS-137:	0.08860	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

These values are decayed through April 1, 1986.

SITE ID NO.: 216-N-5

ALIAS: 212-P-Trench, 216-N-5 Trench

STATUS: Inactive

DIMENSIONS:

Length: 80 ft

Width: 15 ft

Depth: 6 ft

Diameter: 0 ft

FACILITY: Crib

ELEVATION: 575 ft

WATERTABLE: 170 ft

LOCATION: 200 North

COORDINATES: N55408/W63130, N55495/W63225 (Diagonally)

SITE DESCRIPTION:

Trench, with dimensions of 80 ft. long x 15 ft. wide x 6 ft. deep.

SERVICE DATES: 1952-1952

SERVICE HISTORY:

From 5/52 to 6/52 the site received the basin water and sludge cleanout from the 212-P Basin during shutdown of the area. The site was retired in 6/52.

REFERENCES:

Documents: ARH-2806, RHO-CD-673, HW-55176

Photographs: 122440-28-CN

Drawings: H-3-57210

SITE ID NO.: 216-N-5

CHEMICALS DISPOSED

TOTAL VOLUME DISPOSED:

7570000 Liters

No chemicals discharged.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	FR-144:	0.00000
MN-54:	0.00000	FM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.08520	NE-237:	0.00000
Y-91:	0.00000	PO-238:	0.00000
NB-95:	0.00000	PO-239:	0.00000
ZR-95:	0.00000	PO-240:	0.00000
TC-99:	0.00000	PO-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.35600
CS-137:	0.09600	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

These values are decayed through April 1, 1986.

SITE ID NO.: 216-N-6

ALIAS: 212-R Swamp, 216-N-6 Swamp

STATUS: Inactive

DIMENSIONS:

Length: 500 ft

Width: 150 ft

Depth: 3 ft

Diameter: 0 ft

FACILITY: Pond

ELEVATION: 557 ft

WATERTABLE: 152 ft

LOCATION: 200 North

COORDINATES: Head: N53600/W60030, End: N54350/W60115

SITE DESCRIPTION:

Pond, with 500 ft. long x 150 ft. wide bottom dimensions.

SERVICE DATES: 1944-1952

SERVICE HISTORY:

From 9/44 to 6/52 the site received the normal overflow from the 212-R Basin. The site was retired in 6/52 when 212-R was shut down.

REFERENCES:

Documents: ARH-2806, RHO-CD-673, HW-55176

Photographs: 122440-26-CN

Drawings: H-3-57210

SITE ID NO.: 216-N-6

CHEMICALS DISPOSED

TOTAL VOLUME DISPOSED: 946000000 Liters

No chemicals discharged.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	FR-144:	0.00000
MN-54:	0.00000	FM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.07830	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.05710
ZR-95:	0.00000	PU-240:	0.01320
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00152
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.32800
CS-137:	0.08860	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

These values are decayed through April 1, 1986.

SITE ID NO.: 216-N-7

ALIAS: 212-R Trench, 216-N-7 Trench
STATUS: Inactive
DIMENSIONS:

Length: 80 ft
Width: 15 ft
Depth: 6 ft
Diameter: 0 ft

FACILITY: Crib
ELEVATION: 571 ft
WATERTABLE: 152 ft

LOCATION: 200 North
COORDINATES: N55399/W60505, N55482/W60605 (Diagonally)

SITE DESCRIPTION:

Trench, with dimensions of 80 ft. long x 15 ft. wide x 6 ft. deep.

SERVICE DATES: 1952-1952

SERVICE HISTORY:

From 5/52 to 6/52 the site received the basin water and sludge cleanout waste from 212-R Basin. The site was retired in 6/52 when 212-R was shut down.

REFERENCES:

Documents: ARH-2806, RHO-CD-673, HW-55176
Photographs: 122440-25-CN
Drawings: H-3-57210

SITE ID NO.: 216-N-7

CHEMICALS DISPOSED

TOTAL VOLUME DISPOSED: 7570000 Liters

No chemicals discharged.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.08520	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.35600
CS-137:	0.09600	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

These values are decayed through April 1, 1986.

REFERENCE 22

Hanford Ground Water Database Printouts for Wells of Concern

[illegible]

ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED

1	1	EEEE	TTTT	PPPP	RRRR	III	1	1	TTTT
1	1	E	T	P	R	I	1	1	T
14	1	E	T	P	R	I	14	1	T
1 11	1	EEEE	T	PPPP	RRRR	I	1 11	1	T
1 111	E	T	P	R	R	I	1 111	1	T
1 11	E	T	P	R	R	I	1 11	1	T
1 11	EEEE	T	P	R	R	III	1 11	1	T

[illegible][illegible]

File CHRAU(1240.FMT) (4121,17,0), last revised on 14-AUG-1987 1135, is a 26 block sequential file owned by UIC (NETPRINT). The records are variable length with implicit (CH) carriage control. The longest record is 0 bytes.

Job 210 (1159) queued to LPA0 on 14-AUG-1987 11:35 by user NETPRINT, UIC (NETPRINT), under account 48610010 at priority 100, started on printer +LPA01 on 14-AUG-1987 11:35 from queue LPA0.

[illegible]

for Cyanide

[illegible]

[illegible]

CELL	DATE	COLLECTED IN	DATE	VALUE	FLAG	ANALYSIS	SPONSOR
6-5-73	1/19/67	CYANIDE	4.9500E+02	U	D6	Cyanide	
2-41-73	5/11/77	U-C-CE 1	1.3700E+00	R	D6	Kranian	
2-41-73	7/20/87	U-C-CE 1	1.3700E+04	R			
2-41-73	5/10/87	U-C-CE 1	1.1300E+04	R			
CELL <th>DATE</th> <th>COLLECTED IN</th> <th>DATE</th> <th>VALUE</th> <th>FLAG</th> <th>ANALYSIS</th> <th>SPONSOR</th>	DATE	COLLECTED IN	DATE	VALUE	FLAG	ANALYSIS	SPONSOR
6-5-73	1/13/66	RT-HAIE	1.6000E+06	R	D6	Trifluor	
6-5-73	2/21/66	RT-HAIE	2.2100E+00	U	D6		
6-5-73	1/11/66	RT-HAIE	1.5500E+02	U	D6	Trifluor	

~~BK6 Carbon Tetrachloride~~ listed as Tetrane

2.0000E+03 H 06 Carbon tetrachloride listed as Tetra

06 25/07/2017

D6 Kraniken

H	10430000*1	>	313010
H	10430000*2	>	707400
H	001710000*3	>	01

8	1043000.1	131-1
8	1043000.1	131-1
8	1043000.1	131-1

2.0000E+03 31.47.17

0	66+31.002-2	111111
0	1.6093679	111111

DATE	TIME	LOCATION	ANALYST	SP. NO.
11/11/11	14:11	FLA 3	ANALYST	SP. NO.

SECRET

Tritium

[illegible][illegible]

4	4	EEEE	TTTT	PPPP	AAAA	III	4	N	TTTT		
4	4	E	T	P	P	R	R	I	4	N	T
IN	4	E	T	P	P	AA	4	I	N	N	T
4	4	EEEE	T	PPPP	AAAA	I	4	N	N	T	
4	4	E	T	P	R	R	I	4	N	N	T
I	4	E	T	P	R	R	I	4	N	N	T
I	4	EEEE	T	P	R	R	III	N	N	T	

[illegible][illegible]

HHHHHHHHHH
 CHHHHHHHHH
 HHHHHCHHHH

94328.055

LESS
CONSTITUTENT
CODE FLAG ANALYSIS
VALUE

CONSTITUTION
ERROR

COLLECTION
DATE

104	-1.6543E+37	-1.6543E+37	12/11/86
124	1.7400E+01	-1.6543E+37	2/14/86
124	1.1409E+04	3.0400E+03	3/11/86
124	2.3409E+04	6.2400E+03	9/18/86
124	1.3409E+04	-1.6543E+37	5/17/86
124	1.3409E+04	-1.6543E+37	7/13/86
124	0.5100E+03	-1.6543E+37	9/13/86
124	9.5100E+03	-1.6543E+37	10/16/86
124	1.9100E+04	-1.6543E+37	11/15/86
124	5.5100E+03	-1.6543E+37	1/16/87
124	9.5409E+03	-1.6543E+37	2/11/87
124	6.0709E+03	-1.6543E+37	3/24/87
124	7.5500E+03	-1.6543E+37	5/15/87
124	9.2309E+03	-1.6543E+37	6/11/87
124	4.2609E+03	-1.6543E+37	7/22/87
105	1.3100E+03	9.5100E+03	7/22/87
114	5.8100E+01	9.5100E+03	7/22/87
115	1.3500E+01	9.5100E+03	7/22/87

PRINTER CONSTITUTION CODE, LESS FLAG, ANALYSIS VALUE, COUNTING ERROR,
COLLECTION DATE OF ANALYSIS AND CONSTITUENT CODE E1 "104", "103", "104",
"105", "124" SINTERED
CONSTITUTION CODE, COLLECTION DATE IN 2-11-89. TIP

$$\mu_{Total} = {}^{234}\mu + {}^{235}\mu + {}^{238}\mu = 2748 \text{ pCi/L}$$

Constituent Codes

$${}^{234}\mu = 183$$

$${}^{235}\mu = 184$$

$${}^{238}\mu = 185$$

Don't pen initials
to

104
124
183
184
185

(104/104 pCi/L)
per

KKKKKKKKKK
KKKKKKKKKK
KKKKKKKKKK

1	1	EEEE	TTTT	PPPP	RRRR	III	N	N	TTTT
2	2	E	T	P	P	R	N	N	T
3	3	E	T	P	P	R	N	N	T
4	4	EEEE	TTTT	PPPP	RRRR	III	N	N	TTTT
5	5	E	T	P	P	R	N	N	T
6	6	E	T	P	P	R	N	N	T
7	7	EEEE	TTTT	PPPP	RRRR	III	N	N	TTTT

[illegible][illegible]

Job 01 (1712) queued to LPA0 on 18-AUG-1987 13:10 by user NETPRINT, UIC (NETPRINT), under account W8610010 at priority 100, started on printer LPA01 on 19-AUG-1987 13:14 from queue LPA0.

KKKKKKKKKK
KXKKKKKKKK
KKKKKKKKKK

943210.053

LESS
CONSTITUENT THAT ANALYSIS COUNTING COLLECTION
CODE FLAG VALUE ERROR DATE
111 1.2409E+02 -1.4741E+17 2/03/07 BKG in pl/k Uranium
PRITY CONSTITUTE IT+CODE, LESS+TIA+FLAG, TIA+VSI+VALUE, COUNTING+ERROR,
COLLECTING+DATE OF ANALYST VIT
CELL+DATE E1 6-55-89 AND CONSTITUTE IT+CODE E1 "104", "103", "104",
"105", "124" SORTED BY
CONSTITUTE IT+CODE, COLLECTING+DATE IN 6-55-89, T.P

Constituent Code = 104 U Total

07OCT86

PNL I-129 RESULTS ON WELL WATER SAMPLES COLLECTED SINCE 01JAN85

ANALYSIS NUMBER	USER NUMBER	STARTED yrmoda	ENDED yrmoda	I-129 10**-6 pCi/l	ERROR (%)	COMMENTS
89279	699 101-48B	6	850912	16.1	6.1	#4846 WATER FOR I129 (9/12/85), 699 101-48B, HANFORD
89376	699 101-48B	6	860529	43.9	4.9	#4846 WATER FOR I129 (5/29/86), 699 191-48B, HANFORD
89270	699 25-55	6	850912	49.6	6.1	#4415 WATER FOR I129 (9/12/85), 699 25-55, HANFORD
89377	699 25-55	6	860529	93.5	4.1	#4415 WATER FOR I129 (5/29/86), 699 25-35, HANFORD BKG I
89271	699 26-15A	6	850912	2775763.9	7.2	#4518 WATER FOR I129 (9/12/85), 699 26-15A, HANFORD
89272	699 27-08	6	850912	2078439.7	5.7	#4557 WATER FOR I129 (9/12/85), 699 27-08, HANFORD
89341	699 27-08	6	860127	2417553.3	3.7	#4557 WATER FOR I129 (1/27/86), 699 27-08, HANFORD
89273	699 32-22	6	850912	5577959.1	7.1	#4794 WATER FOR I129, (9/12/85), 699 32-22, HANFORD
89379	699 32-22	6	860606	4888290.4	3.7	#4794 WATER FOR I129 (6/6/86), 699 32-22, HANFORD
89342	699 35-09	6	860127	218171.1	3.9	#4419 WATER FOR I129 (1/27/86), 699 35-09, HANFORD
89168	699 35-66	-5	850530	6965857.8	7.3	#4494 WATER FOR I129 (5/30/85), 699 35-66, HANFORD
89167	699 35-70	-5	850530	66934831.4	7.3	#4441 WATER FOR I129 (5/30/85), 699 35-70, HANFORD
89343	699 35-70	6	860127	101823772.4	4.1	#4441 WATER FOR I129 (1/27/86), 699 35-70, HANFORD DG I
89274	699 37-E04	6	850900	22357.8	5.4	#4876 WATER FOR I129 (9/85), 699 37-E04, HANFORD
89301	699 37-E04	6	860107	24354.6	5.6	WATER FOR I129 (1/17/86), 699 37-E04, HANFORD
89171	699 39-39	-5	850530	223.6	88.4	#4791 WATER FOR I129 (5/30/85), 699 39-39, HANFORD
89177	699 39-39	-5	850530	292.4	7.4	RE-RUN #4791 WATER FOR I129 (5/30/85), 699 39-39, HANFORD
89275	699 41-01	6	850910	255174.3	5.4	#4858 WATER FOR I129 (9/10/85), 699 41-01, HANFORD
89302	699 41-1	6	860108	214289.9	5.6	WATER COLLECTED 1/8/86 FOR I-129, 699-41-1, HANFORD
89276	699 41-23	6	850912	2944270.8	7.1	WATER FOR I129, (9/12/85), 699 41-23, HANFORD
89344	699 41-23	6	860127	4720044.4	3.5	#4430 WATER FOR I129 (1/27/86), 699-41-23, HANFORD DG I
89277	699 46-04	6	850910	92918.8	5.4	#4863 WATER FOR I129 (9/10/85), 699 46-04, HANFORD
89303	699 46-04	6	860108	139627.9	5.6	WATER FOR I129 (1/8/86), 699 46-04, HANFORD

07OCT86

PNL I-129 RESULTS ON WELL WATER SAMPLES COLLECTED SINCE 01JAN85

ANALYSIS NUMBER	USER NUMBER	STARTED yrmoda	ENDED yrmoda	I-129 10 ⁻⁶ pCi/l	ERROR (%)	COMMENTS
89345	699 48-07	6	860127	309.8	4.0	#4756 WATER FOR I129 (1/27/86), 699 48-07, HANFORD
89278	699 50-85 0	6	850912	8.2	6.4	#4497 WATER FOR I129 (9/12/85), 699 50-85 0, HANFORD
89346	699 50-85 0	6	860127	177.5	3.7	#4497 WATER FOR I129 (1/27/86), 699-50-85 0, HANFORD
89156	DB-7/597-812 FT.	5	850425	227.0	9.2	SAMP.#P85-216, DB-7 PUMP ACTUATOR, (MABTON) THRU RESIN COLUMN
89157	DB-7/597-812 FT.	5	850425	343.1	9.1	SAMP.#P85-217, DB-7 PUMP ACTUATOR, (MABTON) THRU RESIN COLUMN
89151	R299E 17-1	5	850401	22528490.7	6.4	#2328 WATER FOR I129, R299E 17-1, HANFORD
89166	R299E 17-1	5	850530	14500875.9	7.3	#2328 WATER FOR I129 (5/30/85), R299E 17-1, HANFORD
89174	R299E 17-1	5	850621	18614242.4	7.6	SPECIAL SAMPLE FOR I129 (6/21/85), R299E 17-1, HANFORD
89179	R299E 17-1	5	850712	23003503.4	7.2	#2328 WATER FOR I129 (7/12/85), R299E 17-1, HANFORD
89210	R299E 17-1	5	850801	33973544.3	9.3	SPECIAL SAMPLE FOR I129 (8/1/85), R299E 17-1, HANFORD
89216	R299E 17-1	5	850820	26659261.6	7.1	SPECIAL SAMPLES FOR I129 (8/20/85), R299E 17-1, HANFORD
89281	R299E 17-1	6	850924	24400606.8	5.7	#2328 WATER FOR I129 (9/24/85), R299E 17-1, HANFORD
89284	R299E 17-1	5	851112	25183753.5	5.7	#2328 WATER FOR I129 (11/12/85), R299E 17-1, HANFORD
89297	R299E 17-1	6	860102	29366888.3	5.6	WATER COLLECTED 1/2/86 FOR I-129, R299 17-1, HANFORD
89154	R299E 17-9	5	850401	31992971.9	6.4	#2514 WATER FOR I129, R299E 17-9, HANFORD
89165	R299E 17-9	5	850530	20454961.8	7.2	#2514 WATER FOR I129 (5/30/85), R299E 17-9, HANFORD
89175	R299E 17-9	5	850621	27973693.6	7.6	SPECIAL SAMPLE FOR I129 (6/21/85), R299E 17-9, HANFORD
89211	R299E 17-9	5	850801	22808393.5	7.1	SPECIAL SAMPLE FOR I129 (8/1/85), R299E 17-9, HANFORD
89217	R299E 17-9	5	850820	32407331.6	7.2	SPECIAL SAMPLE FOR I129 (8/20/85), R299E 17-9, HANFORD
89282	R299E 17-9	6	850924	30239431.1	5.7	#2514 WATER FOR I129 (9/24/85), R299E 17-9, HANFORD
89285	R299E 17-9	5	851112	26123892.1	5.7	#2514 WATER FOR I129 (11/12/85), R299E 17-9, HANFORD
89298	R299E 17-9	6	860102	31637015.7	5.7	WATER COLLECTED 1/2/86 FOR I-129, R299E 17-9, HANFORD
89169	R299E 24-02	5	850530	10575585.2	7.3	#2329 WATER FOR I129 (5/30/85), R299E 24-02, HANFORD

REFERENCE 23

129I, 60Co and 106Ru Measurements on Water Samples From the
Hanford Project Environs, BNWL-SA-4478, January 1973

N. E. BALLOU
BNWL-SA-4478

^{129}I , ^{60}Co AND ^{106}Ru MEASUREMENTS
ON WATER SAMPLES
FROM THE HANFORD PROJECT ENVIRONS

January 1973



Battelle

Pacific Northwest Laboratories
Richland, Washington 99352

^{129}I , ^{60}Co and ^{106}Ru Measurements on
Water Samples from the Hanford Project Environs*

F. P. Brauer and H. G. Rieck, Jr.

Battelle
Pacific Northwest Laboratories
P. O. Box 999
Richland, Washington 99352

January, 1973

*This paper is based on work performed under United States
Atomic Energy Commission Contract AT(45-1)-1830.

947210-1558

^{129}I , ^{60}Co and ^{106}Ru Measurements on
Water Samples from the Hanford Project Environs

F. P. Brauer and H. G. Rieck, Jr.

ABSTRACT

Groundwater flow and contamination patterns beneath the Hanford project reservation have been studied since the early days of the project. The measurement of radioactive materials at concentrations much below those required for radiation protection are useful for tracing groundwater movement and detection of potential contamination problems before they are apt to occur.

Groundwater samples from a number of wells on or near the Hanford reservation have been analyzed for ^{129}I by neutron activation analysis and for gamma radioactivity by low-level coincidence gamma-ray spectrometry. The major radionuclides in addition to natural radioactivity detected in the underground waters by gamma-ray spectrometry were ^{106}Ru and ^{60}Co . Local river and rain water samples were also analyzed for ^{129}I and long-lived radionuclides.

Special sample collection methods were developed to prevent contamination of the water samples during collection. Anions travel farther than cations in underground water systems since soils are primarily cation exchangers and retain the cations. Anion exchange techniques were used in the field and the laboratory to recover the desired radionuclides. Sample sizes ranged up to several thousand liters.

This paper discusses the sample collection methods, analysis methods, and results obtained. The methods used were found to provide high sensitivity for groundwater studies.

^{129}I , ^{60}Co and ^{106}Ru Measurements on
Water Samples from the Hanford Project Environs

F. P. Brauer and H. G. Rieck, Jr.

INTRODUCTION

Groundwater flow and contamination patterns beneath the Hanford project have been studied since the early days of the project. A large number of wells are available on the Hanford reservation for sampling of the groundwater.⁽¹⁾ Routine surveillance data on the status of groundwater contamination resulting from disposal of Hanford plant effluents are reported periodically.⁽²⁾ Analyses used for routine surveillance of radioactivity include total-beta and tritium determinations. The analytical methods selected have generally been limited to those required to assure that concentrations of radioactivity in groundwater is safe for human consumption although the groundwater on the Hanford Reservation is not used as potable water supplies.⁽³⁾

The measurement of radioactive nuclides at concentrations much below those required for radiation protection are useful for tracing the rate and direction of groundwater movement and detection of possible contamination problems before they reach significant levels. One method for improving the detection sensitivity is by the analysis of larger samples. The usefulness of total-beta measurements on large samples is limited by the natural radioactivity and salt content of the samples. Isotopic concentration of tritium from large water samples is difficult and expensive. Other radiochemical analysis methods are available for the analysis of groundwater tracers and are discussed below.

Since radionuclide retention by soil is primarily a cation absorption process, anionic radionuclides serve as better groundwater tracers. Fission product iodine should serve as a good tracer for following the movement of groundwaters. The only fission product iodine isotope with a sufficiently long half-life for hydrologic studies is ^{129}I . The long (1.6×10^7 year) half-life and low specific activity (370 dpm per micro-

During the period of time since 1962 different well-sampling methods have been employed. Exact sampling conditions were not recorded for most of the pre-1968 well samples. Clean sample containers were supplied by the laboratory prior to collection of some of these samples. Some of the wells were sampled by using a bucket on a rope to lift water to the surface. Repeated sampling was required to obtain several liters of water.

The extent to which care was taken to prevent contamination of the pre-1968 samples by the sampling equipment or surface soil is uncertain.

Starting in 1968 the sample collections were conducted by members of the laboratory staff to assure that adequate precautions were taken to prevent contamination of the samples. Thorough flushing of pumps, hoses, pipes, and sample containers was done before sampling. Either new sample containers or used sample containers of known history have been used. Offsite wells were sampled by means of the pumping facilities located at the wells. Most Hanford project wells do not contain pumps and several pumping systems have been employed.

Early 1971 sampling by pumping was done with a submersible pump which was lowered into the well on a 1/4" diameter steel cable. Power to the pump was supplied by an electrical cable and water was delivered to the surface through a 3/4" diameter polyethylene tube. The support-power cable and tubing bundle was washed with demineralized water just outside the well as the unit was being lowered into the well. Normally, the pump was lowered to a point 5 to 10 feet below the static water level. Sampling a well involved pumping for a 30-minute interval to flush the well, then collecting samples in two 13-gallon plastic carboys. After sampling was completed, the system was removed from the well and moved to another location. During the placement in the well of the pump and tubing bundle it was necessary to drag the whole assembly across the ground surface as the unit was being lowered. Consequently, even with the washing operation being performed, the possibility of surface contamination being introduced into the well could not be ignored.

The problems of possible introduction of surface contamination by installation of the pumping system and of cross contamination

with a cheesecloth soaked in demineralized water as it was being lowered into the well.

The inner pipe was next implaced inside the outer pipe. The venturi-jet assembly was attached to a 21-foot section of 1" diameter PVC pipe with a combination of steel and PVC plastic fittings. This section was then lowered, with washing, inside the outer pipe. After securely clamping the top end, another 21-foot section was attached with a 1" diameter coupling. PVC cement was used and after a suitable curing time this additional section was lowered. The procedure was continued until the venturi-jet assembly was positioned in the 5-foot section of schedule 40 outer pipe. The section of schedule 40 pipe was required for a positive seal between the inner and outer pipe by the leather packer on the venturi-jet assembly.

A casing adapter was installed at the top of the well. The pressure and suction lines from the adapter were connected to the pump with unions to permit easy attachment and removal of the pump. A steel can was inverted over the well casing to prevent entry of surface contamination.

A well was sampled by the following technique. After the pump was attached to the unions, the system was primed or filled with demineralized water. The pump was then operated for 30 minutes at maximum flow (~10 GPM) until the pump outlet-water cleared. Two 13-gallon plastic carboy samples were then collected. The pump was then disconnected and moved to the next location. A typical pumping installation is shown in Figure 1.

In 5 wells, the casing size is 1-1/2" diameter and would not accommodate the standard submersible pump or venturi-jet assembly. An air-lift pumping system was permanently installed in each well. The air-lift system was assembled by inserting 1/2" diameter into 1" diameter polyethylene tubing. The inner surface of the outer tube was cleaned by pushing a demineralized water soaked cheese-cloth plug through the tube ahead of the inner tube. The top end of the system was fitted with a specially fabricated adapter which allows introduction of nitrogen (under pressure) into the annulus between the inner and outer tube. The assembly was lowered into the well to a position where the lower end of the outer tube is

GAMMA-RAY SPECTROMETRY

Radioactivity in natural water samples generally requires concentration prior to gamma-ray spectrometry measurements. The water samples were concentrated by boiling to reduce the sample volume from as much as 26 liters to less than 0.1 liter. Cleanroom laboratories were used to avoid contamination of the sample with fallout and other environmental radioactivity. New laboratory glassware was used for boiling each sample. The Columbia River samples collected downstream from the reactor areas were processed in separate laboratory facilities to prevent cross contamination of low-level water samples. The residual water and salts remaining after boiling were mounted in plastic containers approximately 0.5-inches thick and 5-inches in diameter for counting. Dowex-1 rather than boiling was used for concentration of radioactive anions from some of the large volume water samples.

The radioactive nuclides concentrated in the water and salts remaining after boiling or absorbed on ion exchange resins were identified and measured by low-level gamma-gamma coincidence spectrometry.^(6,7,8,10) Most of the samples were counted with a two-parameter gamma spectrometer consisting of a pair of 6-inch diameter by 5-inch thick NaI(Tl) detectors. The NaI(Tl) detectors each were shielded with NaI light pipes from the radioactivity in the photomultiplier tubes. The detectors were contained in a long plastic anticoincidence shield which reduces both the system background and Compton continuum.⁽⁶⁾ The detector system is shown in Figure 4. Figure 5 shows the positions of various radionuclides in the multiplexed two-parameter gamma-ray spectrometer array. Counting times as long as 5000 minutes were used with the lowest activity samples. Computer techniques were used to process the spectral data.⁽⁹⁾ Smaller sample sizes and less sensitive spectrometers were used to analyze the samples collected prior to 1966.

Several of the more radioactive samples were also measured with a high-efficiency Ge(Li) spectrometer to confirm the NaI(Tl) results.

and comparator standards during irradiation were estimated by gamma-ray spectrometry using several spectra to obtain half-life information. The low-level, beta-gated, multiple-gamma coincidence spectrometry techniques described in references (6, 13, 14, 15) were used when required to measure very small amounts of ^{130}I and ^{125}I . A high sensitivity multiple coincidence gamma-ray detector system used for ^{130}I measurements is shown in Figure 7. The backgrounds achieved with this detector operated in several multiple coincidence modes are shown in Figure 8 and tabulated in Table I. ^{130}I decays with the emission of three or four coincident gamma-rays as seen in its decay scheme (Figure 9). ^{130}I spectra recorded with the multiple coincidence gamma-ray spectrometer are shown on Figure 10. Figures 11 and 12 show similar spectra for the ^{135}I and ^{126}I activities frequently also present in an irradiated iodine sample as a result of the fission of trace impurities and the $^{127}\text{I} (n, 2n) ^{126}\text{I}$ reaction. Discrimination against ^{135}I and ^{126}I when counting ^{130}I can be achieved by $\gamma\text{-}\gamma\text{-}\gamma$ and $\gamma\text{-}\gamma\text{-}\gamma\text{-}\gamma$ coincidence counting. The components in the time dependent spectra resulting from the measurements on a single sample are calculated using a weighted least squares method.⁽¹⁵⁾ The data handling programs outlined in reference (9) were used for calculation of analytical results and preparation of final data tabulations.

EXPERIMENTS

The radionuclides detected by gamma-ray spectrometry in Hanford reservation groundwaters were ^{60}Co , ^{106}Ru , and the natural radioactive nuclides. Several well-water samples collected close to the Columbia River also contained radionuclides characteristic of Hanford reactor effluent.

The results of several sampling and method studies are listed on Table II for the nuclides ^{60}Co , ^{106}Ru , and ^{129}I . Fractions of rain, river, and well-water samples were analyzed in the laboratory by collection of the radionuclides on Dowex-1 columns and by evaporation. Comparison of the results as shown on Table II confirm that the primary species of ^{60}Co and ^{106}Ru in well-waters are

are summarized on Table III. The Hanford-area rain-water ^{129}I results clearly show potential for contamination of well waters. Columbia River water collected upstream and downstream from the Hanford project yielded results that are essentially all the same and substantially lower than local rain except for the ^{60}Co in the downstream Columbia River. The ^{60}Co concentration is decreasing since reactor coolant is no longer discharged to the Columbia River. No significant increase was observed in the ^{129}I concentration in the downstream Columbia River water as the result of Hanford activities. The river-water results can be used to establish the maximum radionuclide levels expected in well samples as the result of the entrance of river water into the ground water system.

The background well-water ^{129}I analyses and distilled-water ^{129}I analyses were positive when corrected for our best estimates of the laboratory blank. These results are very close to the detection limit for ^{129}I and may be the result of an unknown analysis artifact or may represent an approximate value for the ^{129}I content of the samples.

1962-1968 Samples

The ^{129}I concentration values (atoms/liter) observed in water from the wells sampled between 1962 and 1968 have been located on a map of the Hanford Area (Figure 13). When samples from several piezometer tubes in the same well were analyzed, the maximum observed ^{129}I concentration was plotted. Many of the water samples were found to contain much more ^{129}I than was found in the river-water and background-area well-waters. The largest concentrations were observed in water from the 200W and 200E Area wells. ^{129}I concentrations observed in most Hanford project well-waters analyzed were significantly higher than the values observed for the Columbia River.

^{129}I , especially well 699-35-9. This suggests a possible increase in groundwater flow in an easterly direction.

ACKNOWLEDGMENT

The author wishes to acknowledge the assistance of E. I. Wandling who collected many of the recent samples; H. Tenny, R. S. Strebin, Jr. and J. H. Kaye who modified the ^{129}I analysis procedure to handle large water samples; L. A. Bond, S. C. Simpson, V. B. Saling, L. W. Schock, W. L. Orange, J. E. Fager and past members of the Radiochemical Analysis Section who performed the analyses; and N. E. Ballou, R. E. Brown and D. J. Brown for the helpful discussions and comments.

15. W. L. Nicholson, J. E. Schlosser, F. P. Brauer, "The Quantitative Analysis of Sets of Multicomponent Time Dependent Spectra from Decay of Radionuclides," Nucl. Instr. & Methods 25, 45 (1963).

690123
943218.0667

TABLE I

BACKGROUND MEASUREMENTS ON SEGMENTED NaI(Tl) DETECTOR

ANTI- COINCIDENCE SHIELD	BETA GATE	NUMBER OF NaI(Tl) SEGMENTS DETECTING AN EVENT			
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
		COUNT RATES, 0.1-4.0 MeV (CPM)			
NONE	OFF	830	180	23	2.2
NONE	ON	1.0	0.18	0.053	0.005
OFF	OFF	740	125	13	1.5
OFF	ON	0.75	0.16	0.024	0.002
ON	OFF	416	40	3.2	0.54
ON	ON	0.69	0.14	0.018	0.001

TABLE III

SUMMARY OF RAIN, RIVER AND WELL-WATER CONCENTRATIONS,
SAMPLES COLLECTED 1962 to 1972

	Concentration Ranges		
	^{129}I (atoms/liter)	^{60}Co (pCi/l)	^{106}Ru (pCi/l)
Hanford Area Rain	$0.02-6 \times 10^{11}$	0.01-0.2	.5-10.
Upstream Columbia River	$1-5 \times 10^9$	< .01	.2-.4
Downstream Columbia River	$1-2 \times 10^9$.007-.6	.004-2.
Snake River	$1-2 \times 10^9$	\leq .005	.1-.3
Yakima River	$1-2 \times 10^9$	< .003	< .4
Artesian Well 699-53-103	$0.6-6 \times 10^8$		
Washington, D. C. Well	$2-9 \times 10^8$		
Troutdale, Oregon Well	5×10^8	< .004	< .3
Thousand Springs, Idaho Well	2×10^7	< .0003	< .06
Distilled Laboratory Water	$3-7 \times 10^7$	< .007	< .03
Hanford Separations Area Wells	$10^{10}-10^{17}$		100.-2,000,000.
Hanford Reservation Wells near River	$3 \times 10^8-10^{12}$.001-0.3	.001-37.

943218.069

DIAGRAM OF JET PUMP INSTALLATION

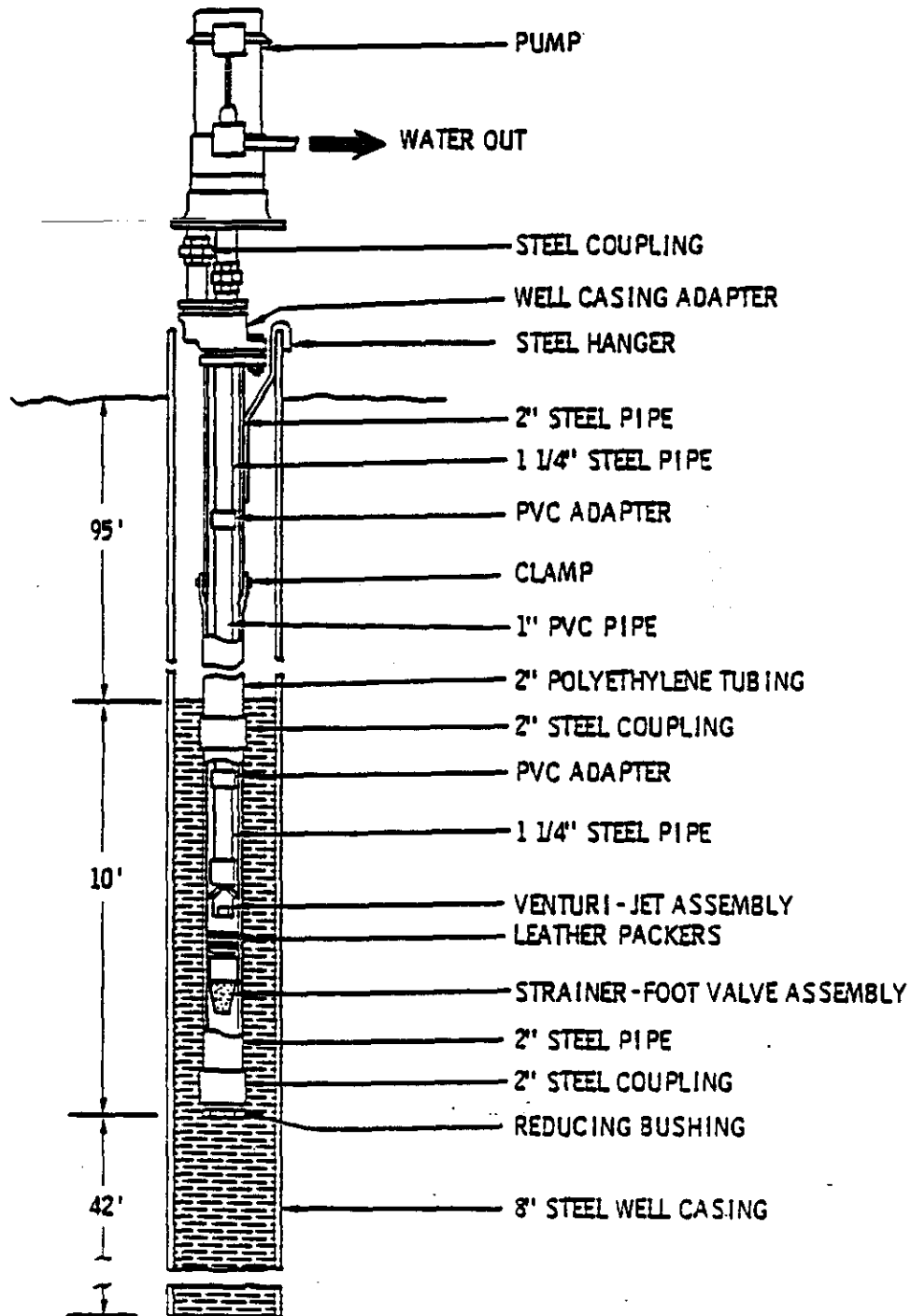
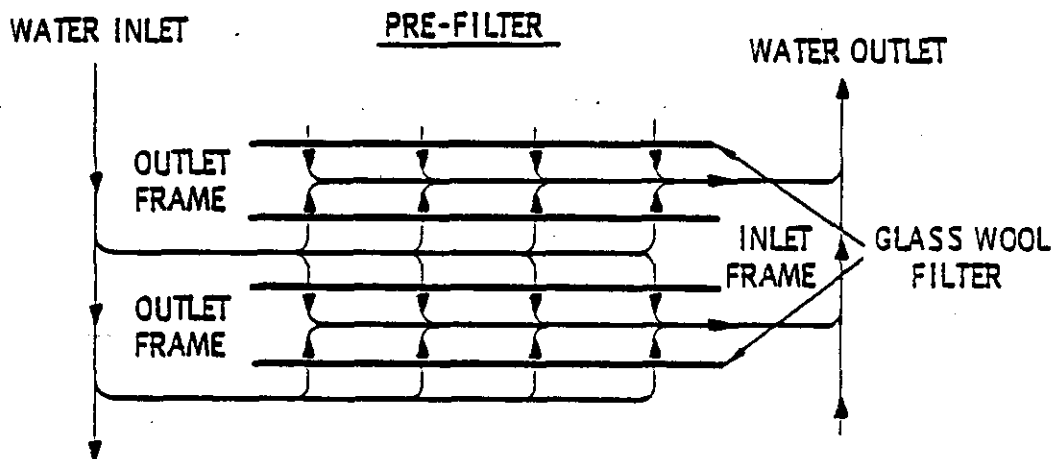
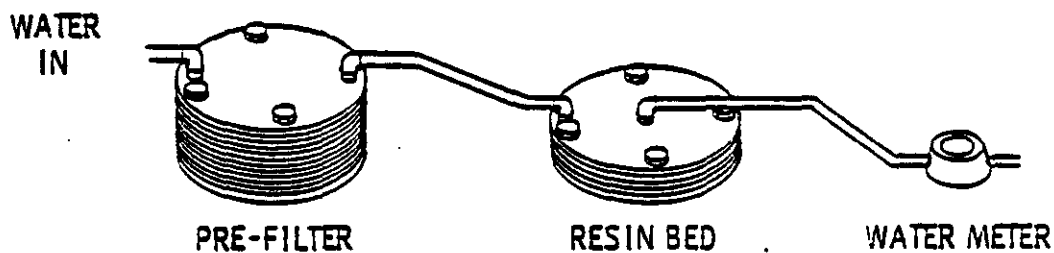


FIGURE 1. DIAGRAM OF JET PUMP INSTALLATION

DIAGRAM OF ION EXCHANGE FILTER SYSTEM

RESIN SYSTEM



RESIN BED

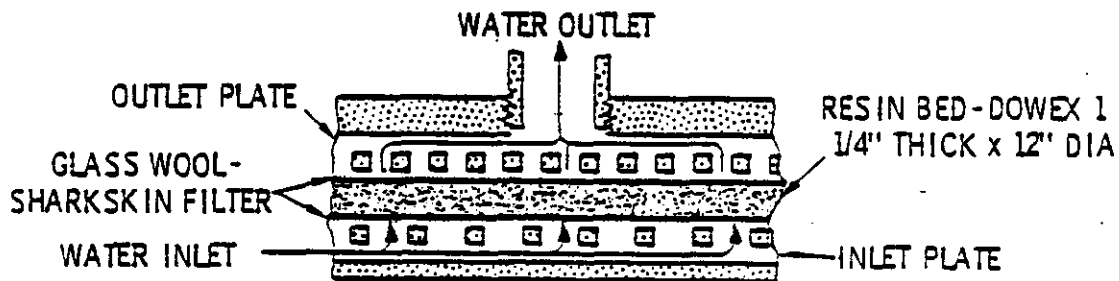


FIGURE 3. DIAGRAM OF ION EXCHANGE FILTER SYSTEM

MULTIPLEXED TWO-PARAMETER GAMMA SPECTROMETER ARRAY

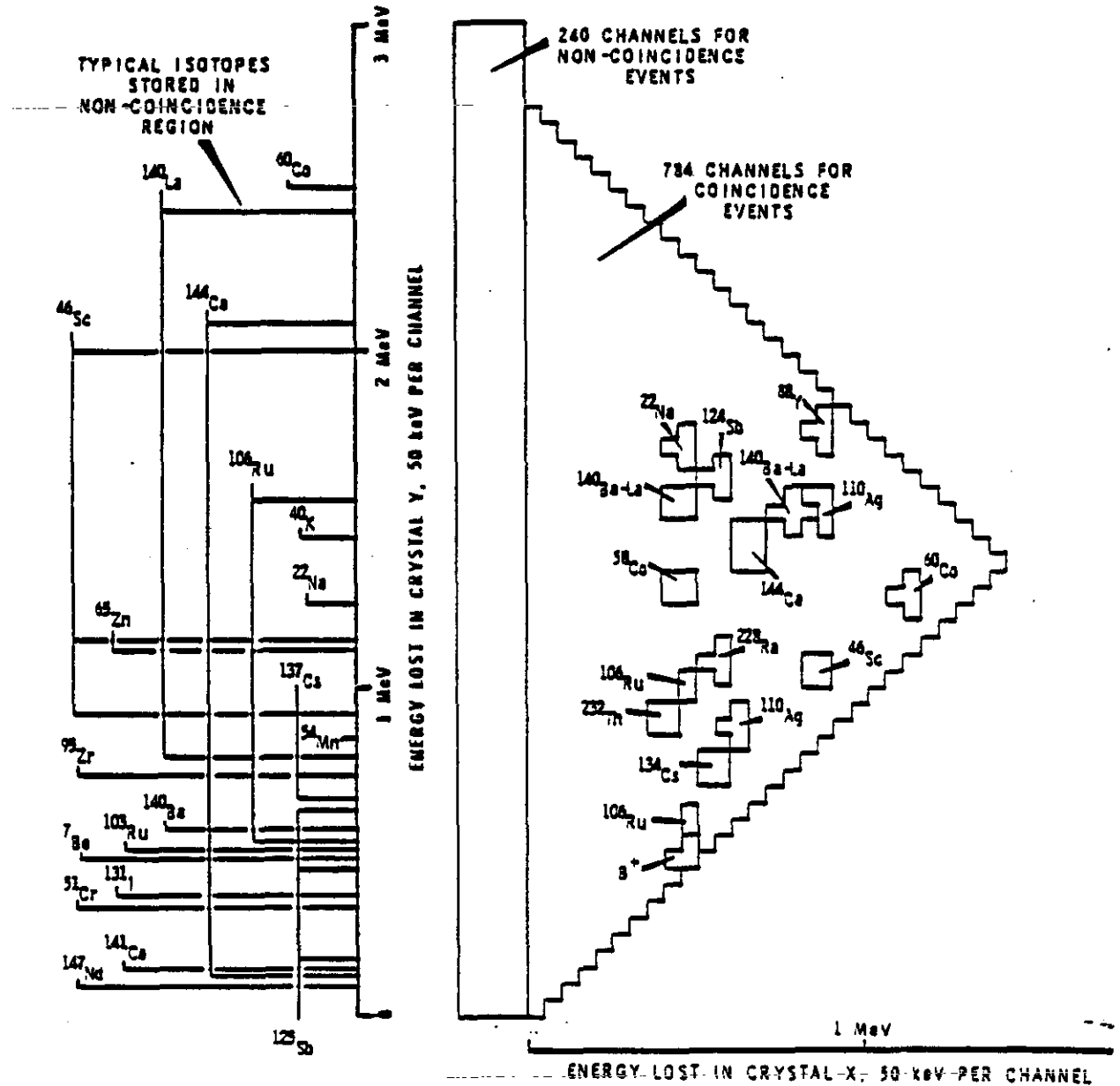


FIGURE 5. DIAGRAM OF TWO-PARAMETER GAMMA-RAY SPECTROMETER DATA ARRAY

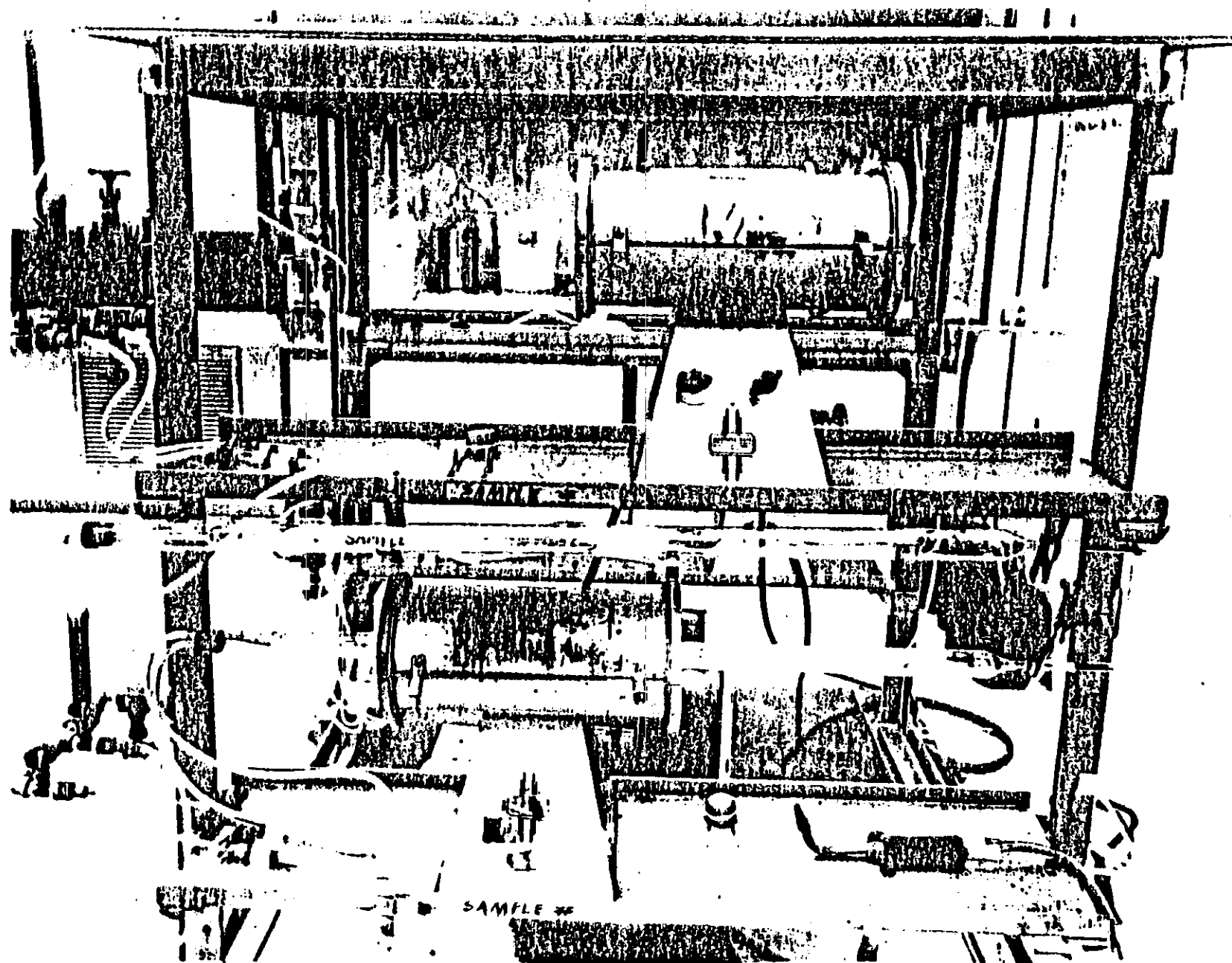
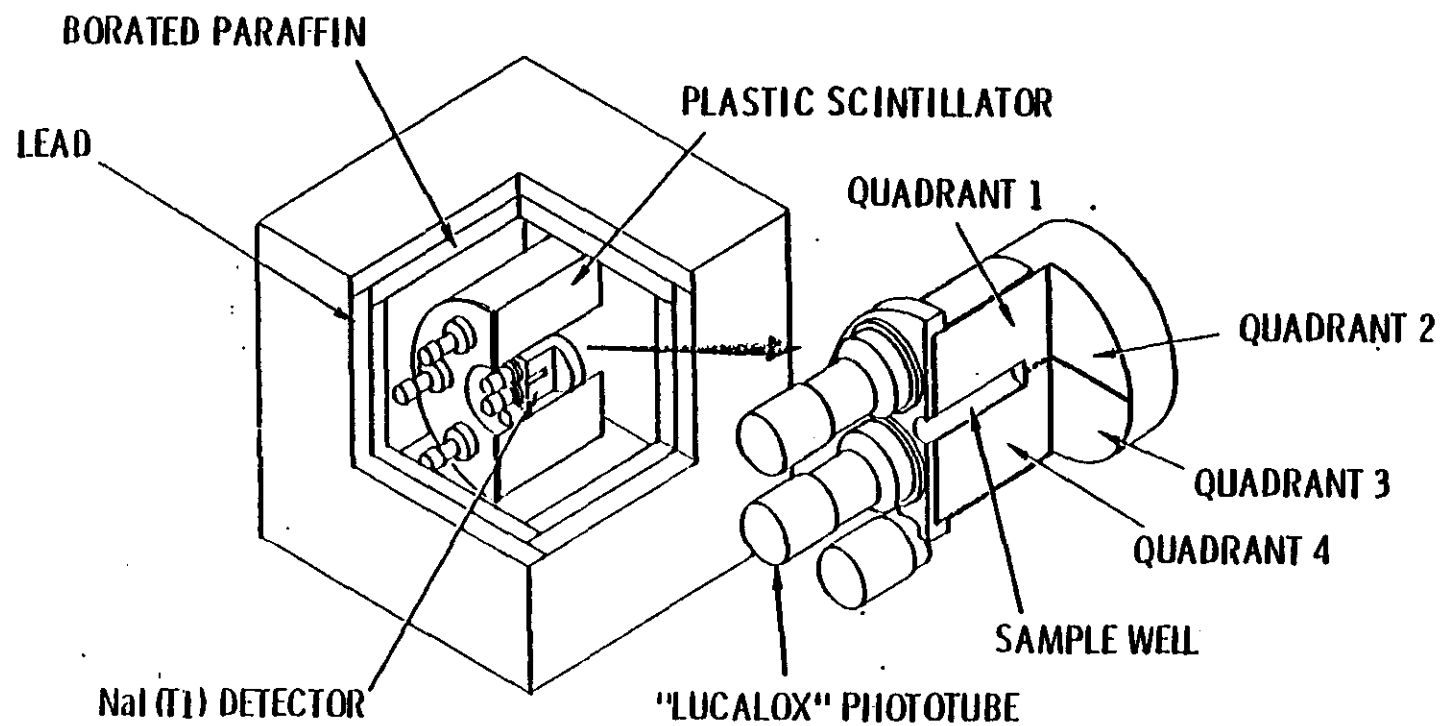


FIGURE 6. COMBUSTION APPARATUS USED FOR SEPARATION OF IODINE FROM RESIN SAMPLE COLLECTORS

MULTIPLE COINCIDENCE GAMMA-RAY DETECTOR



-27-

FIGURE 7. - DIAGRAM OF MULTIPLE COINCIDENCE GAMMA-RAY DETECTOR USED FOR COUNTING ^{130}I

^{130}I DECAY SCHEME SHOWING MULTIPLE GAMMA-RAY TRANSITIONS

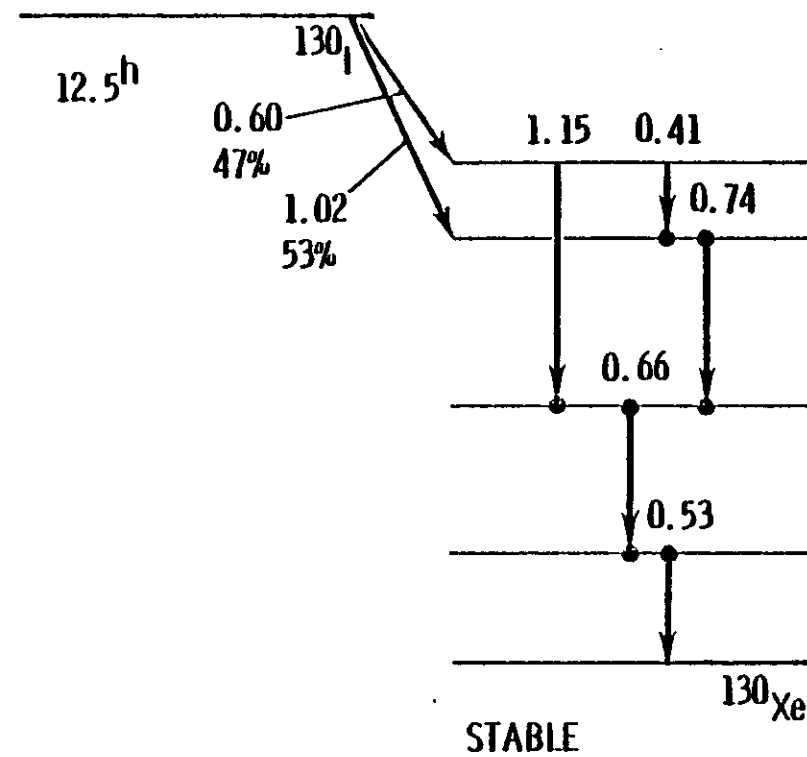


FIGURE 9. ^{130}I DECAY SCHEME SHOWING MULTIPLE GAMMA-RAY TRANSITIONS

^{135}I SPECTRA IN FOUR SEGMENTED NaI(Tl) DETECTOR

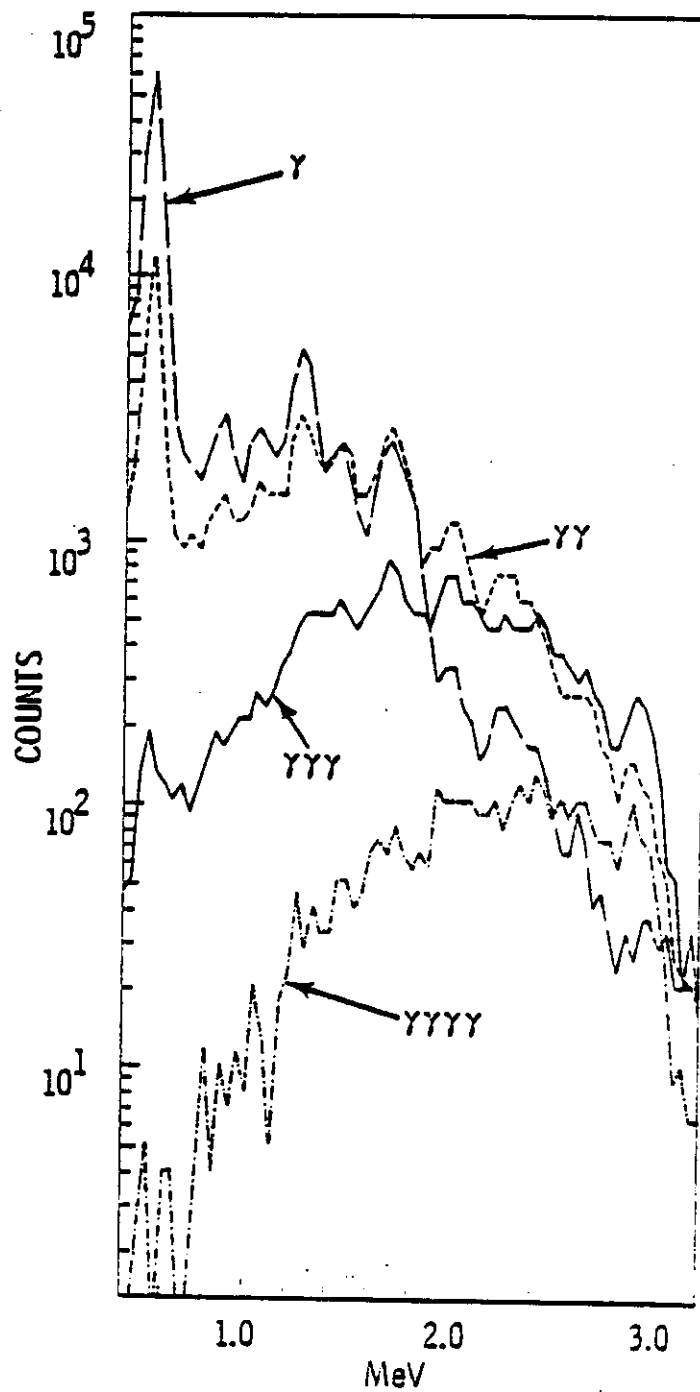


FIGURE 11. ^{135}I SPECTRA IN FOUR-SEGMENTED NaI(Tl) DETECTOR

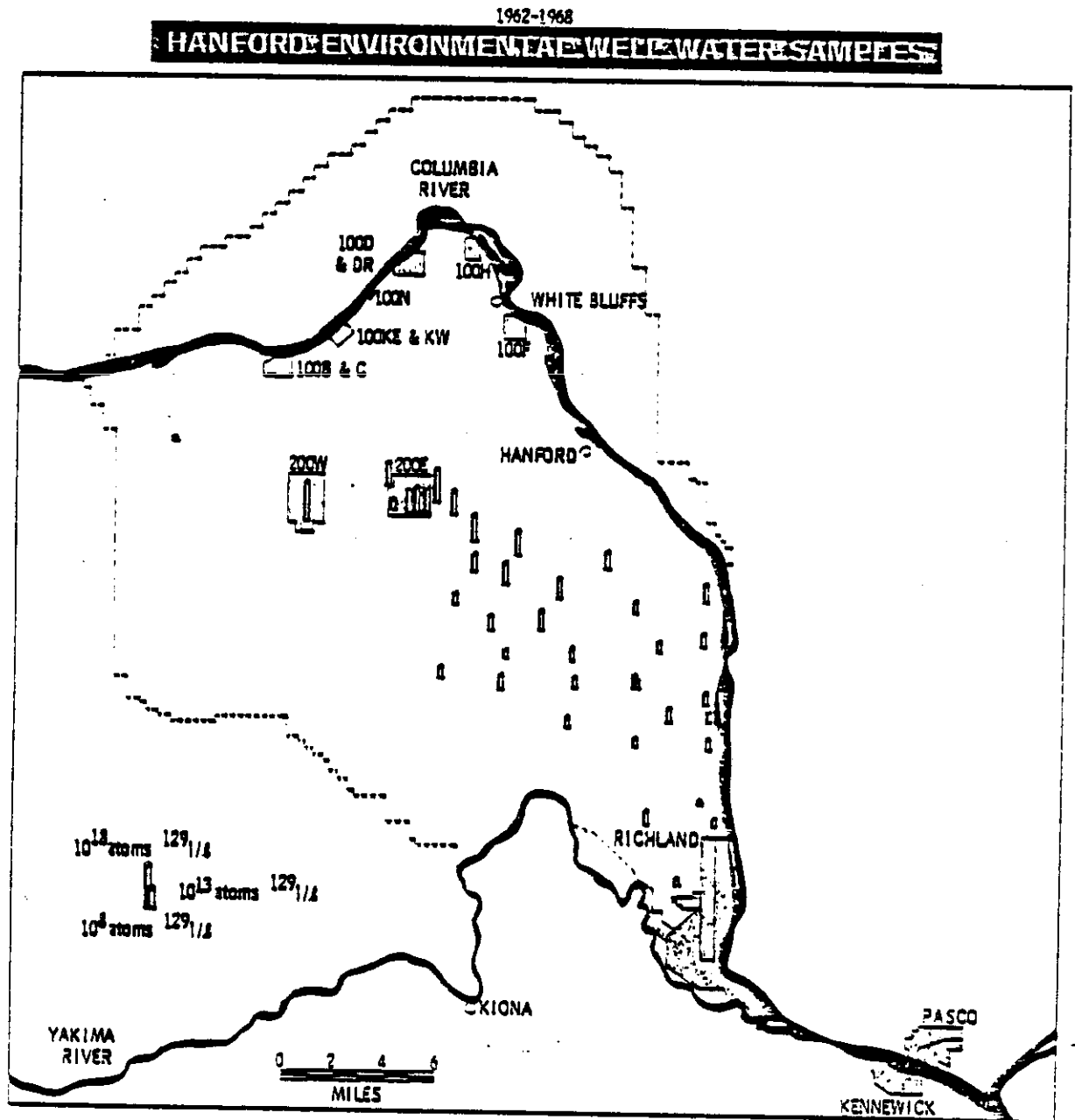


FIGURE 13. 129I IN HANFORD ENVIRONS WELL-WATER SAMPLES 1962-1968

1964-1966

HANFORD ENVIRONMENTAL WELL-WATER SAMPLES

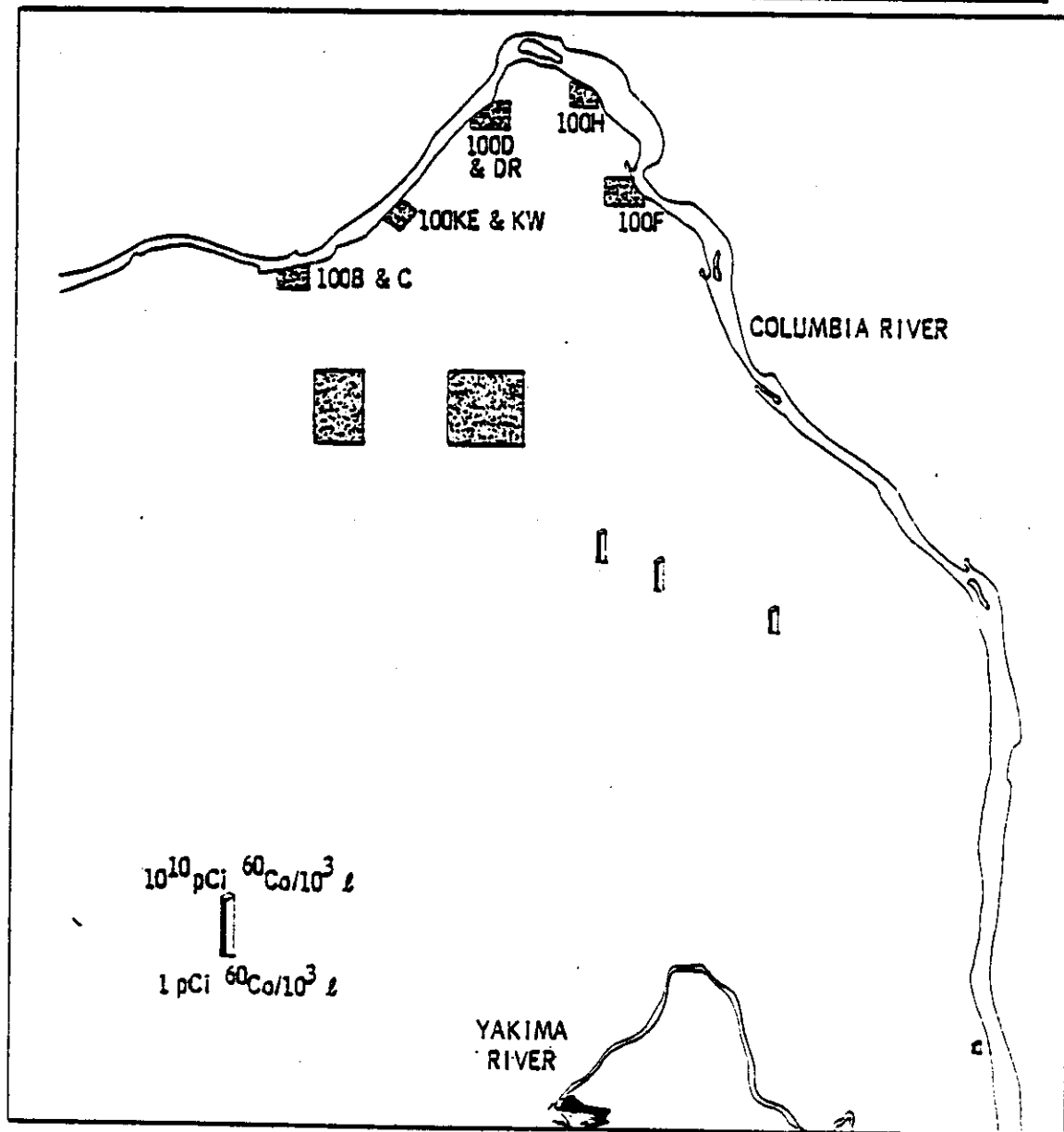


FIGURE 13. ^{60}Co IN HANFORD WELL-WATER SAMPLES 1964-1966

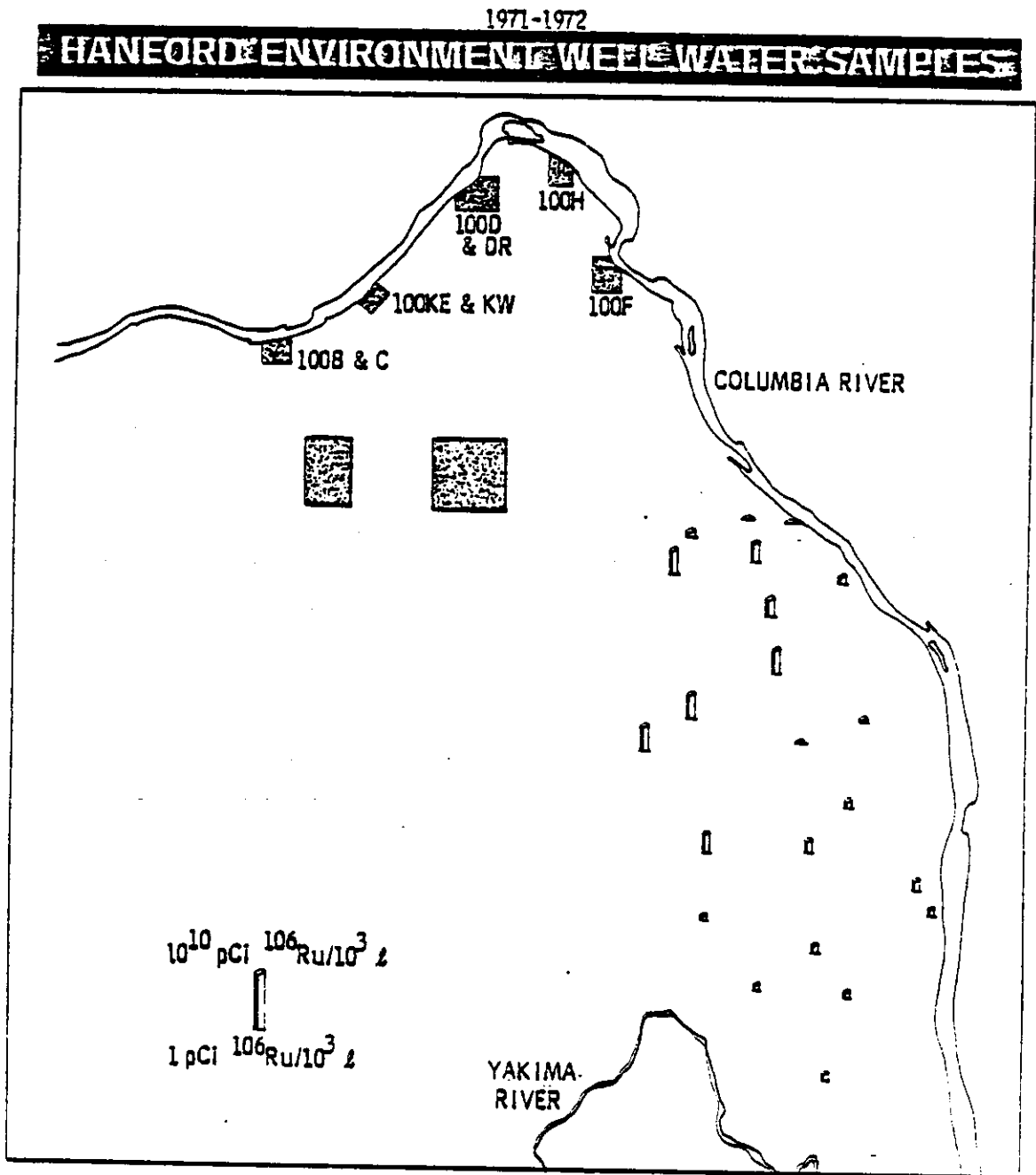


FIGURE 17. ^{106}Ru IN HANFORD WELL-WATER SAMPLES 1971-1972

**THIS PAGE INTENTIONALLY
LEFT BLANK**

REFERENCE 24

Purification of Uranium by IBMK (Hexone) Extraction,

UST-RD-PM-9-80

PURIFICATION OF URANIUM BY IBMK
(HEXONE) EXTRACTION

Principles and Limitations

Uranium, as tetrapropylammonium uranyl trinitrate, is extracted from an acidic solution of acid deficient aluminum nitrate and tetrapropylammonium hydroxide with isobutylmethyl ketone (IBMK). Less than 1% of the one-year-cooled fission products are extracted. Most anions, with the exception of tungstate and ferrocyanide in high mole ratios to uranium do not affect the extraction. Americium, curium, and neptunium do not extract to any appreciable extent, whereas plutonium as Pu(VI) will extract. The Uranium is recovered by back extraction into water while evaporating the ketone. Chemical recoveries are determined using standard uranium or U-232 yield monitors.

Literature References

Booman, G. L., and Rein, J. E., "Uranium," Treatise on Analytical Chemistry, edited by I. M. Kolthoff and P. J. Elving, Part II, Volume 9, Inter-Science Publishers, New York, 1962, pp 1-188.

Maeck, W. J., Booman, G. L., Elliott, M. C., and Rein, J. E., "Separation of Uranium from Diverse Ions," Anal. Chem., Volume 30, 1958, p 1902.

Nietzel, O. A. and de Sesa, M. A., "Spectrophotometric Determination of Uranium with Thiocyanate," Anal. Chem., 29, 1957, p. 756.

Reagents

All reagents are prepared from analytical reagent grade chemicals. Class I D.I. water is used throughout this procedure.

16M HNO₃ - stock reagent.

30% Hydrogen peroxide.

10% Tetrapropylammonium hydroxide.

2M HNO₃ - Pour 125 mL of 16M HNO₃ into D.I. water and dilute to 1 liter.

Isobutylmethyl ketone - stock reagent. Also called hexone and IBMK.

Ruthenium Dye - 2 grams ruthenium trichloride hydrate dissolved and diluted to 1 liter with D. I. water.

2.8M $\text{Al}(\text{NO}_3)_3$ Salting Solution, 1M Acid Deficient:

1. Place 1050 grams (2.31 lb) $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ into a 2 liter beaker.
2. Dilute to 900 mL with D. I. Water. Warm until dissolved.
3. Add 67.5 mL of concentrated NH_4OH (ammonium hydroxide) and stir for several minutes until the hydroxide precipitate dissolves.
4. Cool to less than 50 degrees C and dilute approximately to the 1 liter mark with D. I. Water.
5. Remove any uranium contamination by placing the salting solution in a 2 liter separatory funnel, adding about 200 mL of IBMK and shaking manually for 5 minutes. Drain the salting solution back in the 2 liter beaker. Drain the IBMK to a 400 mL beaker containing 25 mL D.I. water.
6. Check the solution for uranium contamination by evaporating the IBMK to dryness. Plate on 1 1/2" dish and count 50 minutes for possible alpha contamination. After reviewing the data, your supervisor will determine whether the salting solution is ready for use or if it is necessary to repeat step 5. A count rate less than ten times the background would indicate further decontamination of the salting solution unnecessary. This is based on a 90% decontamination efficiency.
7. Add 10 mL of tetrapropylammonium hydroxide and stir until dissolution is complete.

Equipment and Materials

8 position stirring unit

1 1/2 or 2 inch magnetic stir bars

beakers: 50, 100 or 250-mL

heat lamp

Two liter beaker and separatory funnel for reagent purification

Procedure

*Refer to procedure 30-BA-SP for Bioassay Samples or 30-ENV-SP for Environmental Samples for the appropriate bioassay or environmental sample preparation procedure.

1. Boil the solution from a sample preparation procedure to near dryness or until solids start forming. If the sample becomes dry or solidified, add 1 mL (or more as necessary) of 2M HNO_3 .
2. Add 10 mL of $\text{Al}(\text{NO}_3)_3$ salting solution for each 1-2 mL of sample. The salts from 100 mL of urine can be dissolved/suspended in about 1 mL of 2M HNO_3 . Example: Sample volume is ~3 mL. Use 20 mL of $\text{Al}(\text{NO}_3)_3$ salting solution.
3. Add 1 mL ruthenium dye and one teflon coated magnetic stirring bar.

KEY POINT: The ruthenium dye assists in determining phase separation. Ruthenium remains in the aqueous phase (lower layer) and is black in color. The organic (upper layer) phase should be colorless.

4. Add 10 mL of IBMK (hexone) and stir for five minutes on a magnetic stirrer.
5. Remove the beaker from the stirrer and allow the phases to separate.

KEY POINT: If the phases won't separate within 10 minutes, separation can be achieved by centrifuging.

6. Carefully pour most of the IBMK (upper layer) into a labeled 50 mL beaker. At least 90% of IBMK can be poured off in this way.

KEY POINT: If any bottom layer goes into the 50 mL beaker, remove it with a pipet and transfer to the original beaker, or recombine the layers and try the separation again.

7. Add a second 10 mL of IBMK and stir for 2-3 minutes.

Repeat steps 5 and 6, combining with the first IBMK.

8. Place the 50 mL beakers under a heat lamp in the order of increasing sample identification number and fill each beaker to the 40 mL mark with D. I. Water. Evaporate to dryness.

KEY POINT: 1. Arranging the beakers in order will avoid any error in case the IBMK removes any identification from the beaker.

2. Water helps to control the temperature. IBMK can boil under heat lamp temperatures. When this happens, the sample will turn yellow in color and dry to a dark residue. Wet-ash with a few mL 16M HNO₃ and a few drops of 30% H₂O₂.

9. Depending on the type of uranium analysis requested on the sample, proceed to one of the following three procedures:

- a) Only Uranium Isotopic is Requested - Proceed to the Electrodeposition Procedure, 30-ED-02.
- b) Only Natural Uranium requested - Proceed to "Fluorometric Determination of Uranium," 20-U-03 or "Determination of Uranium by Kinetic Phosphorescence Analysis", 20-U-05.

L A S T P A G E

APPROVED FOR USE

[Signature] 1/31/86
Matthew DeLacy 1/31/86
A. Robinson 1/31/86

FLUOROMETRIC DETERMINATION OF URANIUM FOLLOWING PURIFICATION

Principles and Limitations

The residue from the Uranium Purification Procedures (20-U-01) or (20-U-02) is dissolved for fluorometric determination of total uranium. The method involves fusion of the sample in a sodium and lithium fluoride flux at 1750°F and measurement of the yellow-green uranium fluorescence using a fluorophotometer. To adjust for interferences and to quantify the sample reading, a known amount of natural uranium is added to a duplicate aliquot and measured similarly. The fluorometric method can be affected by sample matrix interferences such as quenching agents (i.e., iron) and fluorescent agents (i.e., organics).

Literature References

Booman, G.L. and Rein, J.E., "Uranium", Treatise on Analytical Chemistry, edited by I.M. Kolthoff and P.J. Elving, Part II, Vol. 9, Interscience Publishers, New York, 1962, pp. 1-188.

Reagents

2M HNO₃

Flux for Fluorometric Uranium Determination

1. Add 9.1 g fluorometric grade lithium fluoride to a 1 pound (454g) bottle of fluorometric grade sodium fluoride. Seal the bottle and mix overnight on a rolling mixer.
2. Check the prepared flux by fusing 5 blanks and 5 spikes containing known quantities of uranium and read on a fluorometer prior to use.
3. Spikes should read within 10% of normal values. Blanks are expected to read less than 0.0050.

Equipment and Materials

Beakers, 1-L and 250-mL
Covered metal racks for holding platinum dishes
Platinum dishes

Pipet - 100 uL, 200 uL
Pipet tips
Pelletizer
Fused-pellet fluorometric equipment

Calculations - Uranium Radiometric Yield

dpc = counting efficiency as disintegration per count

Y = sample yield = (cpm)(dpc)/(dpm uranium added to the spike sample)

Calculations - Uranium Fluorometric

SAM = Sample reading

BL = Blank reading

SP = Spike plus sample reading

SPC = Spike value in micrograms per mL

Y = Radiometric spike yield. Use Y = 1.0 if result is not to be yield corrected

V_T = Total sample volume

V_A = Sample volume analyzed

V_R = Volume of 2M HNO₃ to dissolve residue (step 1). Use 4 mL for DOE bioassay samples, 10 mL for all others.

V = Aliquot of V_R

$$\frac{SP - SAM}{SP - SAM} \times \frac{SPC (0.05 \text{ mL})}{Y} \times \frac{V_R}{V} \times \frac{V_T}{V_A} = \text{ug U/sample}$$

This calculation may be used for solid sample by dividing by sample weight in grams.

Section A: Quality Control

1. Quality control checks are to be performed every day that samples are to be analyzed by the fluorometric procedure.
2. Set up the platinum dishes on a covered metal rack, placing 4 low-level dishes and 3 spike dishes in two

separate rows.

KEY POINT: The extra low-level dish is for the blank sample. The spike dishes should be in the front row. The rows are separated to minimize cross-contamination.

3. Add exactly 100 uL (microliters) of QC #1 to a low-level dish and to the spike dish.
4. Repeat Step #3 for QC #2 and QC #3 spikes.
5. Add exactly 30 uL of natural uranium standard to each spike dish.
6. Add 100 uL of 2M HNO₃ to every dish.
7. Place the rack supporting the samples under a heat lamp.
8. Prepare a Fluorometric Analysis Sheet as shown in Procedure #60-23-01 and below:

Sample vol. 100 uL
Spike vol. 30 uL
Spike conc. (value on bottle)
Fusion time 3 minutes

9. Remove the QC rack from under the heat lamp when the dishes are dry. After the QC samples are measured take the data to your supervisor for evaluation. Go to Section C, Fluorometric Analysis.

Section B: Sample Dissolution and Uranium Radiometric Yield

1. To the residue from a uranium purification procedure, add exactly 10 mL (4 mL for DOE bioassay samples) of 2M HNO₃. Swirl to effect dissolution.

NOTE: If the results are to be yield-corrected, go to step 2. If not proceed to Section C.

2. Transfer exactly 1 mL to a previously labeled 1.5 inch s.s. planchet and dry under a heat lamp. Go to Section C, Fluorometric Analysis.
3. Count the planchet for 30 minutes with an alpha proportional counter to determine the U-232 tracer yield.

Section C: Fluorometric Analysis

1. Analyze Hanford DOE and RMI urine samples in duplicate (two spike dishes and two low-level dishes for each sample). Others: one spike, one low-level dish per sample.
2. Set up platinum dishes for the samples on a rack. Place a corresponding spike dish in front of each low-level dish. Add one extra low-level dish for the blank after each set of four samples.
3. Pipet 50 uL of uranium standard containing about 10 micrograms uranium per milliliter into each spike dish.
4. Swirl the sample solutions well and pipet 200 uL (100 uL for ERA samples) into each set of spike and non-spike dishes per sample. Maintain identification by a mapped arrangement.
5. Place the sample rack under a heat lamp and slowly take all dishes to dryness.
6. Prepare to fuse the samples on the fusion wheel as follows:
 - a. Turn on the air purifier.
 - b. Turn on the burner exhaust fan.
 - c. Open the air valve.
 - d. Open the gas tank valve several turns.
 - e. Light the burners.
 - f. Adjust the burners to obtain the desired flame.
7. Place a NaF-LiF flux pellet on each dish.
8. Place the dishes on the fusion wheel in a sample-spike, sample-spike order, and set the timer for three minutes. The fusion temperature is regulated between 1750 and 1780 degrees F. Each sample is fused twice. Retain dish identification by maintaining a consistent order throughout the fusing and reading process.
9. While the samples are fusing, set up the fluorometer as follows:
 - a. Open the light shutter, which is kept closed when not measuring samples.
 - b. Set the reading at zero on all scales.
 - c. Set the #8 position standard to read 3.

KEY POINT: It is necessary to push the middle button on the digital readout if "OL" appears on the display.

d. The #9 position standard should read less than .0025. If it is above .0025, the fluorometer may need service. Consult your supervisor.

e. Recheck the zero.

10. Remove the samples to the metal racks after they have cooled from the second fusion.

11. Prepare the analysis sheet by recording the sample number, volume of sample analyzed, volume of uranium spike used, strength of uranium spike initials of technician, date of analysis and any other comments pertinent to the analysis. See section 60-23 for instructions.

12. Transfer each sample to the platinum dish holder in the fluorometer, close the cover, move sample into position, and record the dial reading on the analysis sheet.

13. After reading the sample, remove the platinum dish from the fluorometer, discard the pellet, and place the platinum dishes in its appropriate "low-level" or "spike" beaker.

14. Add about 200 mL of 16M HNO_3 to each 1-liter beaker containing the platinum dishes. Place on an oscillating hot plate and boil for about 1 hour. Remove and allow to cool. Decant the HNO_3 acid to a cup sink with running water. Rinse with D.I. water liberally and decant to the sink.

KEY POINT: Allow the tap water to run in the sink for at least five minutes to dilute the acid.

15. Repeat step 11.

16. Add about 200 mL of D.I. water to each beaker and place on hot plate again and allow to boil for 30 minutes. Decant D.I. water and rinse twice with D.I. water. Remove as much water as possible and transfer dishes to 250 mL beakers labeled appropriately. The platinum dishes are now ready for re-use.

LAST PAGE

APPROVED FOR USE

[Signature] 1/31/86

William M. Brady 1/31/86

Al Robinson 1/31/86

REFERENCE 25

Determination of Tritium in Water Samples,

UST-RD-PM-9-80

91328.0592

DETERMINATION OF TRITIUM IN WATER SAMPLES

Principles and Limitations

Tritium in water is measured by a direct count of the distilled sample using a liquid scintillation spectrometer. After distillation, a sample of 5 milliliters is pipetted into 15 milliliters of scintillator solution. The mixture is transferred to the refrigerated sample changer of the liquid scintillation counter and is allowed to remain there for ~ 24 hours before counting is begun. This waiting period allows temperature equilibrium to be reached and the decay of chemiluminescence within the plastic vials. The counting efficiency of each sample including corrections for quenching, is determined by using the external standard technique. A quench curve is obtained by counting samples with known amounts of tritium and varying amounts of quenching material. The degree of quenching is determined using an external radioactive source and this is correlated with the counting efficiency of the appropriate standard. When a sample is counted, the liquid scintillation counter determines the sample's quench parameter and compares it to the quench curve to obtain the counting efficiency.

Literature Reference

Florkowski and Williams, "Liquid Scintillation Counting of Tritium in Water with Triton Emulsion Systems", Int. J. Applied Radiation Isotopes, 19, p. 377, (1968).

Standard Test Method for Tritium in Water, ASTM D2476-81.

United States Testing Company, Inc., Computer Calculation Program REES Manual.

Equipment and Materials

Boiling flask, 500 mL

Condensing column

Heating mantle - six position - currently using one manufactured by Glas-Col Company

Spatula

Beaker (50 mL)

Polyethylene bottle (100 mL)

Automatic pipet - 5 mL adjustable with disposable tip

Plastic scintillation vials - 25 mL size to fit LSC sample changer

Automatic dispenser - one liter capacity with 1-20 mL dispenser

Reagents

"Dead" water, water which contains little or not tritium.

Hydrochloric Acid, concentrated.

Potassium hydroxide, pellets

Liquid Scintillation cocktail - A. R. Grade - Ready-Solv MP, a solution prepared by Beckman, is currently being used

Calculations

Type DAT to calculate the tritium concentration in water and the total propagated uncertainty. For samples whose results require immediate reporting, the activity concentration and the counting uncertainty may be manually calculated using the equations below:

$$A = K (C - B_c)$$

$$CU = \pm K \times [2] \text{ SQR } (C/T_c + B_c/T_b)$$

where:

A = activity in pCi/L.

K = $1000 / (2.22 (E) V (Y))$.

CU = two sigma counting uncertainty in pCi/L.

C = gross counts per minute in the tritium region of interest (ROI).

T_c = sample count length in minutes.

B_c = background counts per minute in the tritium ROI.

T_b = background count length in minutes.

1000 = mL per L.

- 2.22 = disintegrations per minute per picocurie.
- E = counting efficiency using a tritium radionuclide standard.
- V = sample volume in mL.
- Y = chemical yield.
- SQR = square root

Note that the above equation for the counting uncertainty represents only the uncertainty from counting statistics, while the computer program calculates the total propagated uncertainty.

Procedure

1. For samples requesting a tritium analysis, save about 500 mL in a sample container. (The sample may be composited for a month or quarter) Take the same volume of sample and measure accurately when compositing.
2. Transfer 250 mL to a boiling flask. Add 1 to 2 grams of potassium hydroxide (1 to 2 pellets) and a boiling chip. Prepare spikes and blanks in accordance with Table 1 of 30-ENV-SP.
3. The boiling flask and condensers are pre-connected on a six position heating unit. Use a 50 mL beaker for the collection vessel.

KEY POINT: Be sure that cold water is running through the condenser column from bottom to top.

4. Turn on the heating mantle and set the timer for 35 minutes, adjust the temperature so that the sample is boiling lightly. After the sample has boiled for a little while, check the beaker. If the distillate volume is 10 mL, remove and immediately replace with a poly bottle. This takes about 15 minutes. Collect about 25 mL of the distillate for the analysis. This takes about 20 minutes.
5. When the sample distillation is finished, allow the glassware to cool and drain the remainder of the sample to waste. Clean the equipment for the next sample by rinsing with concentrated HCl, liberal amounts of D.I. water and finally with "dead" water.
6. Write the sample identification number on the cap of the

scintillation counting vial. Transfer 5 mL of the sample plus 15 mL of scintillation solution to the counting vial. For higher level samples add 1 mL of sample and 4 mL of "dead" water. Cap the samples and mix well by shaking vigorously. A blank is made with "dead" water. A spike is made by adding prepared calibrated H-3 spike (vial code EQM) to a vial containing liquid scintillation cocktail.

KEY POINT: Do not prepare samples in the cassette.
Spilled scintillation solution can destroy them.

7. Clean the vial with a Kimwipe just before loading it into the cassette. The temperature of the liquid scintillation spectrometer is about 50°F.
8. Load the blank in position one, spike (if any) in position two, followed by the samples.
9. Prepare a Tritium Counting Request Card as described in 60-21-01 and indicate the location of each sample in the cassette. There are 10 positions in each cassette, numbered one through ten. If more than one cassette is used for a batch of samples, the position numbers for samples in the second cassette begin with 11.

Counting times:

Low level water	150 minutes
Enriched tritium	3 x 150 minutes
Fruit	150 minutes
Silica Gel (Air)	150 minutes
Milk	150 minutes
Ground water	100 minutes
Intermediate level	50 minutes

10. Transfer the cassettes with scintillation vials and the request ticket to the counting room for liquid scintillation counting. The cassettes are loaded into the Liquid Scintillation counter and the appropriate program is chosen for counting.
11. The samples are kept in the liquid scintillation counter

about one day before counting is begun. This provides time for fluorescence and any other excitation to decay.

12. After counting, remove the samples from the liquid scintillation counter and transfer to storage. Submit all data, along with the Liquid Scintillation Request Card, to the data handler.

L A S T P A G E

APPROVED FOR USE

R. S. Lander 2/6/86

Matthew M. Lundy 1/31/86
Al Robinson 1/31/86

REFERENCE 26

Volatile Organic Analysis, Method 8240,

UST-RD-PM-9-80

Carbon Tetrachloride Analysis

ANALYTICAL GROUP CODE: 730.731

VOLATILE ORGANIC ANALYSIS, METHOD 8240

TAB V

- (1) Volatile organic compounds are determined by GC/MS. The compounds are introduced into the GC/MS by a Purge and Trap device according to Method 5030.
- (2) The Mass Spectrometer is tuned to meet the Ion Abundance Criteria as outlined in Table 2 of method 8240, by direct injection of 50 ng of Bromofluorobenzene (BFB) followed by software or hardware tuning as may be required. Tuning verification is demonstrated at the beginning of every 12-hour work shift by additional injections of 50 ng of BFB.
- (3) Samples with high levels of volatiles, oils, or other compounds that have a high potential for contaminating the system are diluted prior to analysis. It is important to note that this dilution procedure will raise the detection limit of the analytes.
- (4) A system blank is run prior to the analysis of any standards.
- (5) An initial 5 point calibration for each analyte in the "target" list is made prior to the injection of any samples, blanks, or associated QA/QC samples. Response factors are calculated consistent with 7.1.3 of the method.

Calibration is verified by the analysis of a mid-point calibration standard for every 12-hour shift when samples are to be analyzed. The response factor for each analyte must be within $\pm 20\%$ of the response factor used for quantification of sample concentrations.

- (6) A minimum of three surrogate compounds, representing a range of Boiling Points, are added to the samples at a level of 50 ug/L as calculated in the initial 5 mL sample. Recovery limits for the selected compounds are monitored. Control limits for recovery data are calculated from the data base that is obtained from sample analysis. The three surrogate compounds are:

1,2-Dichloroethane
Toluene
Bromofluorobenzene

- (7) Until such time that sufficient in-house data is available, U.S. EPA Control Limits are used as available (see Table A).

Samples that exhibit recoveries outside the control limits are re-analyzed a second time. If the recoveries are still outside of the control limits, it is possibly because of matrix effects.

- (8) Matrix spike recoveries are determined for the following compounds and concentrations:

Compound	Code	Concentration (ppb)
BENZENE	A62	50
TOLUENE	A66	50
TRICHLOROETHENE	A69	50
CHLOROBENZENE	A78	50
1,1-DICHLOROETHENE	A92	50

- (9) A reagent blank is analyzed with each batch of samples. The blank may not contain the compounds listed above at levels exceeding 5 ug/L or 50% of the reported detection limit for that parameter. In the event that this level is exceeded, the appropriate apparatus will be cleaned and blanks will be analyzed until satisfactory results are achieved.

LAST PAGE

Approved For Use:

[Signature] 6-16-86
Neil H. H. Goo 6-16-86

METHOD 8240

GC/MS METHOD FOR VOLATILE ORGANICS

1.0 Scope and Application

1.1 Method 8240 is used to determine volatile organic compounds in a variety of solid waste matrices. This method is applicable to nearly all types of samples, regardless of water content, including groundwater, aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments.

1.2 The detection limit of Method 8240 for an individual compound is approximately 1 µg/g (wet weight) in waste samples. For samples containing more than 1 mg/g of total volatile material, the detection limit is proportionately higher.

1.3 Method 8240 is based upon a purge-and-trap, gas chromatographic/mass spectrometric (GC/MS) procedure. This method is restricted to use by or under the supervision of analysts experienced in the use of purge-and-trap systems and gas chromatograph/mass spectrometers and skilled in the interpretation of mass spectra and their use as a quantitative tool.

2.0 Summary of Method

2.1 The volatile compounds are introduced to the gas chromatograph by direct injection, the Headspace Method (Method 5020), or the Purge-and-Trap Method (Method 5030). Method 5030 should be used for groundwater analysis. The components are separated via the gas chromatograph and detected using a mass spectrometer which is used to provide both qualitative and quantitative information. The chromatographic conditions as well as typical mass spectrometer operating parameters are given.

2.2 If the above sample introduction techniques are not applicable, a portion of the sample can be dispersed in methanol or polyethylene glycol (PEG) to dissolve the volatile organic constituents. A portion of the methanolic or PEG solution is combined with water in a specially designed purging chamber. An inert gas is then bubbled through the solution at ambient temperature and the volatile components are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatile components are trapped. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the components onto a gas chromatographic column. The gas chromatographic column is heated to elute the components, which are detected with a mass spectrometer.

2.3 An aliquot of each sample must be spiked with an appropriate standard to determine percent recovery and detection limits for that sample.

2 / ORGANIC ANALYTICAL METHODS - GC/MS

2.4 Table 1 lists detection limits that can be obtained in wastewaters in the absence of interferences. Detection limits for a typical waste sample would be significantly higher.

TABLE 1. CHROMATOGRAPHIC CONDITIONS AND METHOD DETECTION LIMITS

Parameter	Retention time (min) Column 1 ^a	Method detection limit (µg/l)
Chloromethane	2.3	ND
Bromomethane	3.1	ND
Vinyl chloride	3.8	ND
Chloroethane	4.6	ND
Methylene chloride	6.4	2.8
Trichlorofluoromethane	8.3	ND
1,1-Dichloroethene	9.0	2.8
1,1-Dichloroethane	10.1	4.7
trans-1,2-Dichloroethene	10.8	1.6
Chloroform	11.4	1.6
1,2-Dichloroethane	12.1	2.8
1,1,1-Trichloroethane	13.4	3.8
Carbon tetrachloride	13.7	2.8
Bromodichloromethane	14.3	2.2
1,2-Dichloropropane	15.7	6.0
trans-1,3-Dichloropropene	15.9	5.0
Trichloroethene	16.5	1.9
Benzene	17.0	4.4
Dibromochloromethane	17.1	3.1
1,1,2-Trichloroethane	17.2	5.0
cis-1,3-Dichloropropene	17.2	ND
2-Chloroethylvinyl ether	18.6	ND
Bromoform	19.8	4.7
1,1,2,2-Tetrachloroethane	22.1	6.9
Tetrachloroethene	22.2	4.1
Toluene	23.5	6.0
Chlorobenzene	24.6	6.0
Ethyl benzene	26.4	7.2
1,3-Dichlorobenzene	33.9	ND
1,2-Dichlorobenzene	35.0	ND
1,4-Dichlorobenzene	35.4	ND

ND = not determined.

^aColumn conditions: Carbopack B (60/80 mesh) coated with 1% SP-1000 packed in a 6-ft by 2-mm I.D. glass column with helium carrier gas at a flow rate of 30 ml/min. Column temperature is isothermal at 45° C for 3 min, then programmed at 8° C per minute to 220° and held for 15 min.

3.0 Interferences

3.1 Interferences coextracted from the samples will vary considerably from source to source, depending upon the particular waste or extract being tested. The analytical system, however, should be checked to ensure freedom from interferences under the conditions of the analysis by running method blanks. Method blanks are run by analyzing organic-free water in the normal manner. The use of non-TFE plastic tubing, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

3.2 Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride) through the septum seal into the sample during shipment and storage. A field blank prepared from organic-free water and carried through the sampling and handling protocol can serve as a check on such contamination.

3.3 Cross contamination can occur whenever high-level and low-level samples are sequentially analyzed. To reduce cross contamination, the purging device and sample syringe should be rinsed out twice, between samples, with organic-free water. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of organic-free water to check for cross contamination. For samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds, or high organohalide levels, it may be necessary to wash out the purging device with a soap solution, rinse with distilled water, and then dry in a 105° C oven between analyses.

3.4 Low molecular weight impurities in PEG can be volatilized during the purging procedure. Thus, the PEG employed in this method must be purified before use as described in Section 5.2.

4.0 Apparatus and Materials

4.1 Sampling equipment

4.1.1 Vial: 25-ml capacity or larger, equipped with a screw cap (Pierce #13075 or equivalent). Detergent wash, rinse with tap and distilled water, and dry for 1 hr at 105° C before use.

4.1.2 Septum: Teflon-faced silicone (Pierce #12722 or equivalent). Detergent wash, rinse with tap and distilled water and dry at 105° C for 1 hr before use.

4.2 Purge-and-trap device: The purge-and-trap device consists of three separate pieces of equipment: the purging chamber, trap, and the desorber. Several complete devices are now commercially available.

4 / ORGANIC ANALYTICAL METHODS - GC/MS

4.2.1 The purging chamber must be designed to accept 5-ml or 25-ml samples with a water column at least 3 cm deep. The gaseous head space between the water column and the trap must have a total volume of less than 15 ml. The purge gas must pass through the water column as finely divided bubbles with a diameter of less than 3 mm at the origin. The purge gas must be introduced no more than 5 mm from the base of the water column. The purging chamber, illustrated in Figure 1, meets these design criteria.

4.2.2 The trap must be at least 25 cm long and have an inside diameter of at least 2.5 mm. The trap must be packed to contain the following minimum lengths-of-adsorbents: 1.0 cm of methyl-silicone-coated packing (Section 5.3.2), 15 cm of 2,6-diphenylene oxide polymer (Section 5.3.1), and 8 cm of silica gel (Section 5.3.3). The minimum specifications for the trap are illustrated in Figure 2.

4.2.3 The desorber must be capable of rapidly heating the trap to 180° C within 30 sec. The polymer section of the trap should not be heated higher than 180° C and the remaining sections should not exceed 220° C. The desorber design, illustrated in Figure 2, meets these criteria.

4.2.4 The purge-and-trap device may be assembled as a separate unit or be coupled to a gas chromatograph as illustrated in Figures 3 and 4.

4.3 Gas chromatograph/mass spectrometer system

4.3.1 Gas chromatograph: An analytical system complete with a temperature-programmable gas chromatograph and all required accessories including syringes, analytical columns, and gases.

4.3.2 Column: 2-m x 2-mm I.D. stainless steel or glass, packed with 1% SP-1000 on 60/80 mesh Carbopack B or equivalent.

4.3.3 Mass spectrometer: Capable of scanning from 40 to 250 amu every 3 sec or less, utilizing 70 volts (nominal) electron energy in the electron impact ionization mode and producing a mass spectrum which meets all the criteria in Table 1 when 50 ng of 4-bromofluorobenzene (BFB) is injected through the GC inlet or introduced in the purge-and-trap mode.

4.3.4 GC/MS interface: Any GC-to-MS interface that gives acceptable calibration points at 50 ng per injection for each compound of interest and achieves acceptable tuning performance criteria (see Section 9) may be used. GC-to-MS interfaces constructed of all glass or glass-lined materials are recommended. Glass can be deactivated by silanizing with dichlorodimethylsilane. The interface must be capable of transporting at least 10 ng of the components of interest from the GC to the MS.

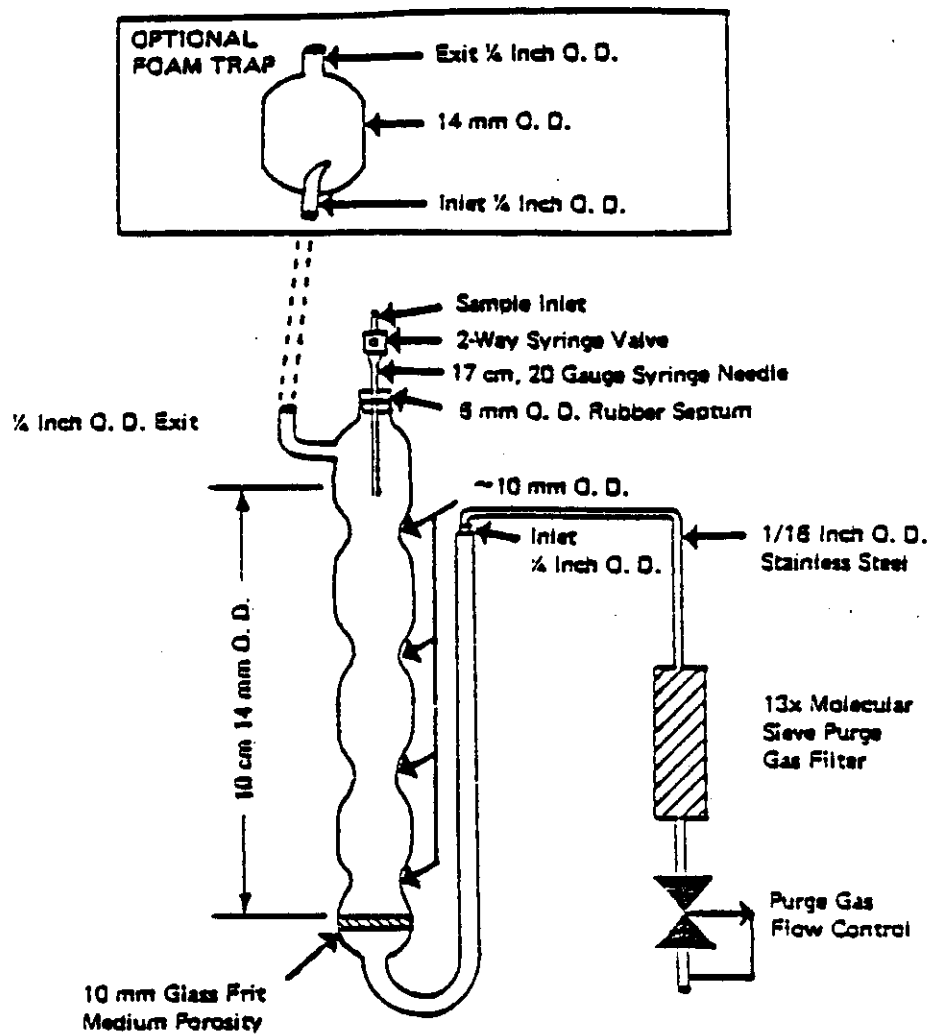


Figure 1. Purging chamber.

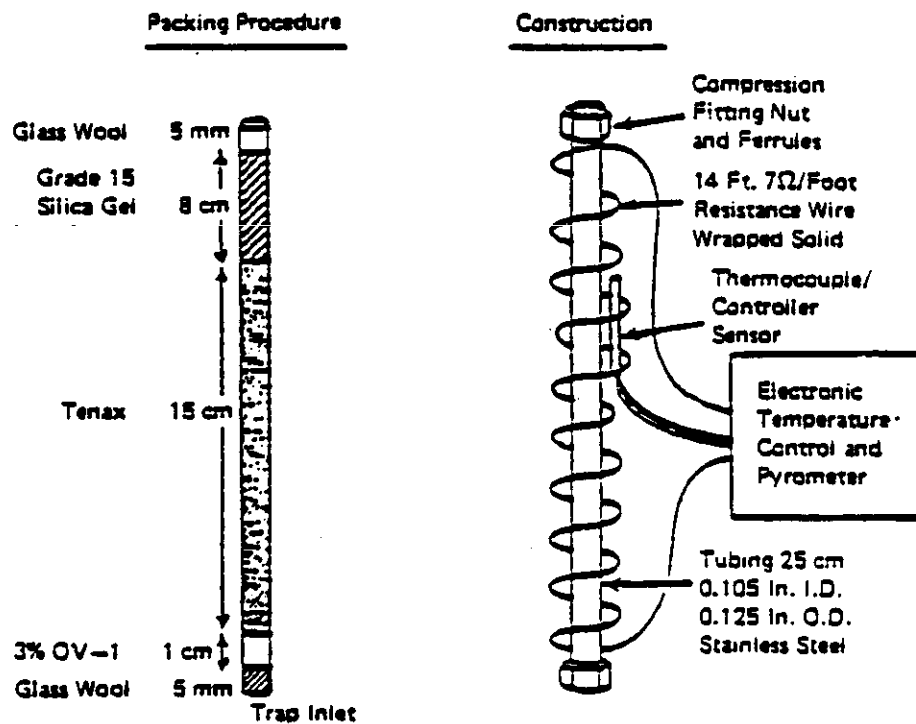


Figure 2. Trap packings and construction to include desorb capability.

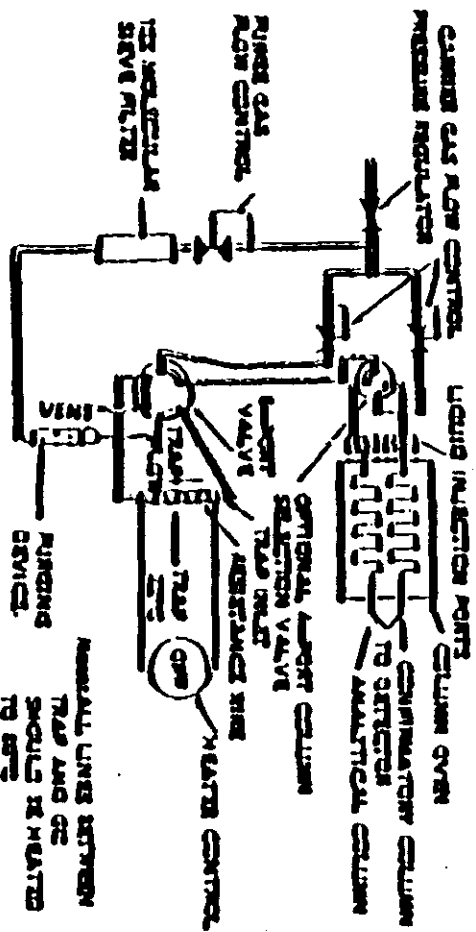


FIGURE 1. Schematic of purge and trap device - purge mode

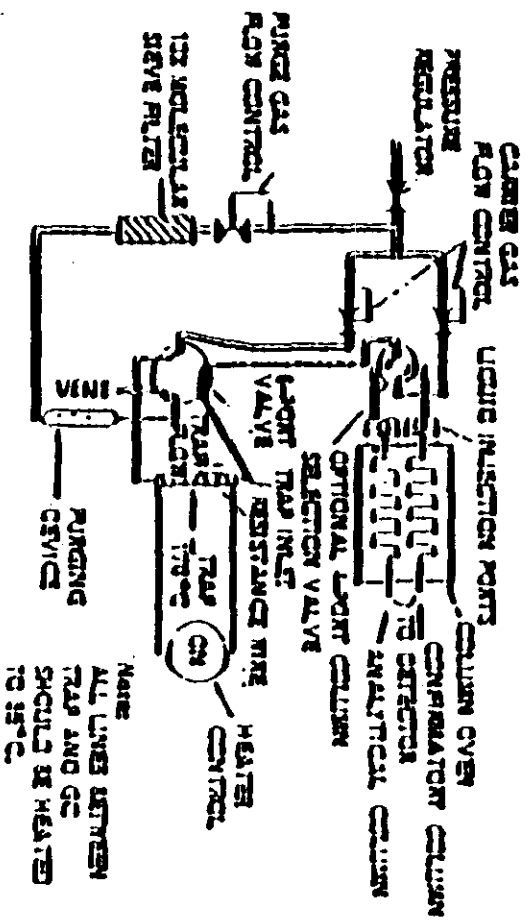


Figure 4. Schematic of purge and trap device - desorb mode

9413218.0607

4.3.5 Data system: A computer system must be interfaced to the mass spectrometer that allows the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program. The computer must have software that allows searching any GC/MS data file for ions of a specific mass and plotting such ion abundances versus time or scan number. This type of plot is defined as an Extracted Ion Current Profile (EICP). Software must also be available that allows integrating the abundance in any EICP between specified time or scan number limits. Hardware and software must be available to transform the data into a compatible format. These generally consist of a 9-inch, 800-bpi tape drive and the associated software.

4.4 Sample transfer implements: Implements are required to transfer portions of solid, semisolid, and liquid wastes from sample containers to laboratory glassware. The transfer must be accomplished rapidly to avoid loss of volatile components during the transfer step. Liquids may be transferred using a hypodermic syringe with a wide-bore needle or no needle attached. Samples should be introduced into the syringe by (1) removing the plunger from the syringe, (2) pouring the sample into the barrel, and (3) replacing the barrel and inverting the syringe to remove any air trapped in the syringe. Do not draw the sample up into the syringe. Solids may be transferred using a conventional laboratory spatula, spoon, or coring device. A coring device that is suitable for handling some samples can be made by using a glass tubing saw to cut away the closed end of the barrel of a glass hypodermic syringe.

TABLE 2. BFB KEY ION ABUNDANCE CRITERIA

Mass	Ion abundance criteria
50	15 to 40% of mass 95
75	30 to 60% of mass 95
95	Base Peak, 100% Relative Abundance
96	5 to 9% of mass 95
173	less than 2% of mass 174
174	greater than 50% of mass 95
175	5 to 9% of mass 174
176	greater than 95% but less than 100% of mass 174
177	5 to 9% of mass 176

4.5 Syringes: 5-ml and 25-ml glass hypodermic, equipped with 20-gauge needle, at least 15 cm in length.

4.6 Micro syringes: 10- μ l, 25- μ l, 100- μ l, 250- μ l, and 1000- μ l. These syringes should be equipped with 20-gauge needles having a length sufficient to extend from the sample inlet to within 1 cm of the glass frit in the purging device (see Figure 1). The needle length required will depend upon the dimensions of the purging device employed.

4.7 Centrifuge tubes: 50-ml round-bottom glass centrifuge tubes with Teflon-lined screw caps. The tubes must be marked before use to show an approximate 20-ml graduation.

4.8 Centrifuge: Capable of accommodating 50-ml glass tubes.

4.9 Syringe valve: 2-way, with Luer ends (2 each) (Hamilton #86725 valve equipped with one Hamilton #35033 Luer fitting, or equivalent).

4.10 Syringe: 5-ml, gas-tight with shut-off valve.

4.11 Bottle: 15-ml, screw-cap, Teflon cap liner.

4.12 Balance: Analytical, capable of accurately weighing 0.0001 g.

4.13 Rotary evaporator: equipped with Teflon-coated seals (Buchi Rotavapor R-110, or equivalent).

4.14 Vacuum pump: mechanical, two-stage.

5.0 Reagents

5.1 Reagent water: Reagent water is defined as a water in which an interferent is not observed at the method detection limit of the compounds of interest.

5.1.1 Reagent water may be generated by passing tap water through a carbon filter bed containing about 500 g of activated carbon (Calgon Corp., Filtrasorb-300, or equivalent).

5.1.2 A water purification system (Millipore Super-Q or equivalent) may be used to generate reagent water.

5.1.3 Reagent water may also be prepared by boiling water for 15 min. Subsequently, while maintaining the temperature at 90° C, bubble a contaminant-free inert gas through the water for 1 hr. While still hot, transfer the water to a narrow-mouth screw-cap bottle and seal with a Teflon-lined septum and cap.

10 / ORGANIC ANALYTICAL METHODS - GC/MS

5.1.4 Reagent water may also be purchased under the name "HPLC water" from several manufacturers (Burdick and Jackson, Baker and Waters, Inc.).

5.2 Reagent PEG: Reagent PEG is defined as PEG having a nominal average molecular weight of 400, and in which interferences are not observed at the method detection limit for compounds of interest.

5.2.1 Reagent PEG is prepared by purification of commercial PEG having a nominal average molecular weight of 400. The PEG is placed in a round-bottom flask equipped with a standard taper joint, and the flask is affixed to a rotary evaporator. The flask is immersed in a water bath at 90-100° C and vacuum is maintained at less than 10 mm Hg for at least 1 hr using a two-stage mechanical pump. The vacuum system is equipped with an all-glass trap, which is maintained in a dry ice/methanol bath.

5.2.2 In order to demonstrate that all interfering volatiles have been removed from the PEG, a reagent water/PEG blank must be analyzed.

5.3 Trap materials

5.3.1 2,6-Diphenylene oxide polymer: 60/80-mesh Tenax, chromatographic grade or equivalent.

5.3.2 Methyl silicone packing: 3 percent OV-1 on 60/80 mesh Chromosorb-W or equivalent.

5.3.3 Silica gel, Davison Chemical (35/60 mesh), grade-15 or equivalent.

5.3.4 Prepared trapping columns may be purchased from several chromatography suppliers.

5.4 Methanol: Distilled-in-glass quality or equivalent.

5.5 Calibration standards; stock solutions (2 mg/ml): Stock solutions of calibration standards may be prepared from pure standard materials or purchased as certified solutions. Prepare stock standard solutions of individual compounds in methanol using assayed liquids or gases as appropriate. Because of the toxicity of some of the organohalides, primary dilutions of these materials should be prepared in a hood. A NIOSH/MESA-approved toxic gas respirator should be worn by analysts when handling high concentrations of these materials.

5.5.1 Place about 9.8 ml of methanol in a 10-ml ground-glass-stoppered volumetric flask. Allow the flask to stand, unstoppered, for about 10 min or until all alcohol-wetted surfaces have dried. Weigh the flask to the nearest 0.1 mg.

5.5.2 Add the assayed reference material as described below.

5.5.2.1 Liquids: Using a 100- μ l syringe, immediately add 2 drops of assayed reference material to the flask, then reweigh. The liquid must fall directly into the alcohol without contacting the neck of the flask.

5.5.2.2 Gases: To prepare standards for any compounds that boil below 30° C (e.g., bromomethane, chloroethane, chloromethane, or vinyl chloride), fill a 5-ml valved gas-tight syringe with a reference standard to the 5.0-ml mark. Lower the needle to 5 mm above the methanol meniscus. Slowly introduce the reference standard above the surface of the liquid. The heavy gas rapidly dissolves in the methanol.

5.5.3 Reweigh, dilute to volume, stopper, then mix by gently inverting the flask several times. Calculate the concentration in μ g/ μ l per microliter from the net gain in weight. When compound purity is assayed to be 96% or greater, the weight may be used without correction to calculate the concentration of the stock standard. Commercially prepared stock standards may be used at any concentration if they are certified by the manufacturer or by an independent source.

5.5.4 Transfer the stock standard solution into a Teflon-sealed screw-cap bottle. Store, with minimal headspace, at -10 to -20° C and protect from light.

5.5.5 Prepare fresh standards weekly for gases or for reactive compounds such as 2-chloroethylvinyl ether. All other standards must be replaced after one month, or sooner if comparison with check standards indicates a problem.

5.6 Calibration standards; secondary dilution solutions: Using stock solutions described in Section 5.5, prepare secondary dilution standards in methanol that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the methanol or aqueous PEG calibration solutions prepared as described in Section 6.3.2 will bracket the working range of the analytical system. Secondary dilution standards should be stored with minimal headspace and should be checked frequently for signs of evaporation, especially just prior to preparing calibration standards from them.

5.7 Surrogate standards: Surrogate standards may be added to samples and calibration solutions to assess the effect of the sample matrix on recovery efficiency. The compounds employed for this purpose are 1,2-dibromotetrafluoroethane, bis(perfluoroisopropyl) ketone, fluorobenzene, and m-bromobenzotrifluoride. Prepare methanolic solutions of the surrogate standards using the procedures described in Sections 5.5 and 5.6. The

concentrations prepared and the amount of solution added to each sample should be those required to give an amount of each surrogate in the purging device that is equal to the amount of each internal standard added, assuming a 100% recovery of the surrogate standards.

5.8 Internal standards: In this method, internal standards are employed during analysis of all samples and during all calibration procedures. The analyst must select one or more internal standards that are similar in analytical behavior to the compounds of interest. The analyst must further demonstrate that the measurement of the internal standard is not affected by method or matrix interferences. Because of these limitations, no internal standard can be suggested that is applicable to all samples. However, for general use, D₄-1,2-dichloroethane, D₆-benzene, and D₅-ethylbenzene are recommended as internal standards covering a wide boiling point range.

5.9 4-Bromofluorobenzene (BFB): BFB is added to the internal standard solution or analyzed alone to permit the mass spectrometer tuning for each GC/MS run to be checked.

5.10 Internal standard solution: Using the procedures described in Sections 5.5 and 5.6, prepare a methanolic solution containing each internal standard at a concentration of 12.5 µg/ml.

5.11 Sodium monohydrogen phosphate: 2.0 µ in distilled water.

5.12 n-Nonane and n-dodecane, 98+% purity.

5.13 N-Hexadecane, distilled-in-glass (Burdick and Jackson, or equivalent).

6.0 Sample Collection, Handling, and Preservation

6.1 All samples must be collected using a sampling plan that addresses the considerations discussed in Section One of this manual.

6.2 All samples must be stored in Teflon-lined screw cap vials. Sample containers should be filled as completely as possible so as to minimize headspace or void space. Vials containing liquid sample should be stored in an inverted position.

6.3 All samples must be iced or refrigerated from the time of collection to the time of analysis, and should be protected from light.

7.0 Procedure

7.1 Calibration

7.1.1 Assemble a purge-and-trap device that meets the specifications in Section 4.2 and connect the device to a GC/MS system. Condition the trap overnight at 180° C by backflushing with an inert gas flow of at least 20 ml/min. Prior to use, condition the trap daily for 10 min while backflushing at 180° C.

7.1.2 Operate the gas chromatograph using the conditions described in Section 7.3.5 and operate the mass spectrometer using the conditions described in Section 7.3.2.

7.1.3 Calibration procedure

7.1.3.1 Conduct calibration procedures using a minimum of three concentration levels for each calibration standard. One of the concentration levels should be at a concentration near but above the method detection limit. The remaining two concentration levels should correspond to the expected range of concentrations found in real samples or should define the working range of the GC/MS system.

7.1.3.2 Prepare the final solutions containing the required concentrations of calibration standards, including surrogate standards, directly in the purging device. To the purging device, add 5.0 ml of reagent water or reagent water/PEG solution. This solution is prepared by taking 4.0 ml of reagent water or reagent PEG and diluting to 100 ml with reagent water. The reagent water/PEG solution is added to the purging device using a 5-ml glass syringe-fitted with a 15-cm 20-gauge needle. The needle is inserted through the sample inlet shown in Figure 1. The internal diameter of the 14-gauge needle that forms the sample inlet will permit insertion of a 20-gauge needle. Next, using a 10- μ l or 25- μ l micro-syringe equipped with a long needle (see Section 4.6), take a volume of the secondary dilution solution containing appropriate concentrations of the calibration standards (see Section 5.6). Add the aliquot of calibration solution directly to the reagent water or reagent water/PEG solution in the purging device by inserting the needle through the sample inlet. When discharging the contents of the micro-syringe be sure that the end of the syringe needle is well beneath the surface of the reagent water or water/PEG solution. Similarly, add 20 μ l of the internal standard solution (see Section 5.10). Close the 2-way syringe valve at the sample inlet.

7.1.3.3 Carry out the purge and analysis procedure as described in Section 7.3.4. Tabulate the area response of the primary characteristic ion against concentration for each compound

including the internal standards. Calculate response factors (RF) for each compound as follows:

$$RF = (A_s C_{is}) / (A_{is} C_s)$$

where:

A_s = Area of the primary characteristic ion for the compound to be measured

A_{is} = Area of the primary characteristic ion of the internal standard

C_{is} = Concentration of the internal standard

C_s = Concentration of the compound to be measured.

The internal standard selected for the calculation of the RF of a compound and subsequent quantification of the compound is generally the internal standard that has a retention time closest to that of the compound. It is assumed that a linear calibration plot will be obtained over the range of concentrations used. If the RF value over the working range is a constant (less than 10% relative standard deviation), the RF can be assumed to be invariant, and the average RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios, A_s/A_{is} , versus RF.

7.1.3.4 The RF must be verified on each working day. The concentrations selected should be near the midpoint of the working range. The response factors obtained for the calibration standards analyzed immediately before and after a set of samples must be within $\pm 20\%$ of the response factor used for quantification of the sample concentrations.

7.2 Daily GC/MS performance tests

7.2.1 At the beginning of each day that analyses are to be performed, the GC/MS system must be checked to see that acceptable performance criteria are achieved for BFB (see Table 2).

7.2.2 The BFB performance test requires the following instrumental parameters:

Electron Energy: 70 volts (nominal)

Mass Range: 40 to 250 amu

Scan Time: to give approximately 6 scans per peak but not to exceed 3 sec per scan.

7.2.3 Bleed BFB vapor into the mass spectrometer and tune the instrument to achieve all the key ion criteria for the mass spectrum of BFB given in Table 1. A solution containing 20 ng of BFB may be injected onto the gas chromatographic column in order to check the key ion criteria.

7.2.4 The peak intensity of D₆-benzene is used to monitor the mass spectrometer sensitivity. The peak intensity for D₆-benzene observed during each sample analysis must be between 0.7 and 1.4 times the D₆-benzene peak intensity observed during the applicable calibration runs. For example, if the peak intensity of D₆-benzene observed during calibration was 355,000 area counts, then each subsequent sample or blank must give a D₆-benzene peak intensity of between 250,000 and 500,000 area counts. If the D₆-benzene peak intensity is outside the specified range, the sample must be reanalyzed. If the peak intensity is again outside the specified range, the analyst must investigate the cause of the variability in sensitivity and correct the problem.

7.3 Sample extraction and analysis

7.3.1 The analytical procedure involves extracting the non-aqueous sample with methanol or polyethylene glycol (PEG) and analyzing a portion of the extract by a purge-and-trap GC/MS procedure. The amount of the extract to be taken for the GC/MS analysis is based on the estimated total volatile content (TVC) of the sample. The TVC is estimated by extracting the sample with n-hexadecane and analyzing the n-hexadecane extract by gas chromatography.

7.3.2 The estimated TVC is based on the total area response relative to that of n-nonane for all components eluting prior to the retention time of n-dodecane. The response factor for n-nonane and the retention time of n-dodecane are determined by analyzing a 2- μ l aliquot of an n-hexadecane solution containing 0.20 mg/ml of n-nonane and n-dodecane.

7.3.2.1 The GC analyses are conducted using a flame ionization detector and a 3-m x 2-mm I.D. glass column packed with 10% OV-101 on 100-200 mesh Chromosorb W-HP. The column temperature is programmed from 80° C to 280° C at 8°/min and held at 280° for 10 min.

7.3.2.2 Determine the area response for n-nonane and divide by 0.2 to obtain the area response factor. Record the retention time of n-dodecane.

7.3.2.3 Add 1.0 g of sample to 20 ml of n-hexadecane and 2 ml of 2.0 M Na₂HPO₄ contained in a 50-ml glass centrifuge tube and cap securely with a Teflon-lined screw cap. Shake the mixture vigorously for one minute. If the sample does not disperse

during the shaking process, sonify the mixture in an ultrasonic bath for 30 min. Allow the mixture to stand until a clear supernatant is obtained. Centrifuge if necessary to facilitate phase separation.

7.3.2.4 Analyze a 2- μ l aliquot of the n-hexadecane supernatant using the conditions described in Section 7.3.2.1. Determine the total area response of all components eluting prior to the retention time of n-dodecane and subtract the corresponding area of an n-hexadecane blank. Using the area response factor determined for n-nonane in Section 7.3.2.2, calculate the TVC as follows:

$$\text{TVC} = \frac{\text{TAR}_{\text{sample}} - \text{TAR}_{\text{blank}}}{\text{n-Nonane Area Response Factor}} \times 20$$

where:

TVC = total volatile content of the sample in mg/g

TAR_{sample} = total area response obtained for the sample

TAR_{blank} = total area response obtained for a blank.

7.3.3 The transfer of an aliquot of the sample for extraction with methanol or PEG should be made as quickly as possible to minimize loss of volatiles from the sample.

7.3.3.1 To a 50-ml glass centrifuge tube with Teflon-lined cap, add 40 ml of reagent methanol or PEG. Weigh the capped centrifuge tube and methanol or PEG on an analytical balance.

7.3.3.2 Using an appropriate implement (see Section 4.4), transfer approximately 2 g of sample to the methanol or PEG in the centrifuge tube in such a fashion that the sample is dissolved in or submerged in the methanol or PEG as quickly as possible. Take care not to touch the sample-transfer implement to the methanol or PEG. Recap the centrifuge tube immediately and weigh on an analytical balance to determine an accurate sample weight.

7.3.3.3 Disperse the sample by vigorous agitation for 1 min. The mixture may be agitated manually or with the aid of a vortex-mixer. If the sample does not disperse during this process, sonify the mixture in an ultrasonic bath for 30 min. Allow the mixture to stand until a clear supernatant is obtained as the sample extract. Centrifuge if necessary to facilitate phase separation.

7.3.3.4 The sample extract may be stored for future analytical needs. If this is desired, transfer the solution to a 10-ml screw cap vial with Teflon cap liner. Store at -10 to -20° C, and protect from light.

7.3.4 Reagent water, internal standard solution, and the sample extract are added to a purging chamber that is connected to the purge-and-trap device and that has been flushed with helium during a 7-min trap reconditioning step (see Section 7.3.4.4). The additions are made using an appropriately sized syringe equipped with a 15-cm 20-gauge needle. Open the syringe valve of the sample inlet (shown in Figure 1) and insert the needle through the valve.

7.3.4.1 Add 5.0 ml of reagent water or aqueous sample to which 20.0 μ l of the internal standard solution has been added (see Section 5.10) to the purging chamber. Insert the needle of the syringe well below the surface of the water for the addition of the internal standard solution. If the sample is aqueous go to Section 7.3.5.

7.3.4.2 Add an aliquot of the sample extract from Section 7.3.3.4. The total quantity of volatile components injected should not exceed approximately 10 μ g. If the total volatile content (TVC) of the sample as determined in Section 7.3.1.4 is 1.0 mg/g or less, use a 200- μ l aliquot of the sample extract. If the TVC is greater than 1.0 mg/g, use an aliquot of the sample extract that contains approximately 10 μ g of total volatile components; the volume (in μ l) of the aliquot to be taken can be calculated by dividing 200 by the TVC. If the TVC is greater than 20 mg/g, take a 500- μ l aliquot of the sample extract and dilute to 10 ml with PEG. In this case calculate the aliquot volume (in μ l) of the undiluted extract to be taken by dividing 4,000 by the TVC. If the TVC is less than 1.0 mg/g and greater sensitivity is desired, use a large purging chamber containing 25 ml of reagent water and use a 1.0-ml aliquot of the sample extract.

7.3.4.3 Close the 2-way syringe valve at the sample inlet.

7.3.5 The sample in the purging chamber is purged with helium to transfer the volatile components to the trap. The trap is then heated to desorb the volatile components which are swept by the helium carrier gas onto the GC column for analysis.

7.3.5.1 Adjust the gas (helium) flow rate to 40 ± 3 ml/min. Set the purging device to purge, and purge the sample for 11.0 ± 0.1 min at ambient temperature.

7.3.5.2 At the conclusion of the purge time, adjust the device to the desorb mode, and begin the GC/MS analysis and data acquisition using the following GC operating conditions:

Column: 6-ft x 2-mm I.D. glass column of 1% SP-1000 on Carbo-pack B (60-80 mesh).

Temperature: Isothermal at 45° C for 3 min, then increased at 8° C/min to 220° C, and maintained at 220° C for 15 min.

Concurrently, introduce the trapped materials to the GC column by rapidly heating the trap to 180° C while backflushing the trap with helium at a flow rate of 30 ml/min for 4 min. If this rapid heating requirement cannot be met, the GC column must be used as a secondary trap by cooling it to 30° C or lower during the 4-min desorb step and starting the GC program after the desorb step.

7.3.5.3 Return the purge-and-trap device to the purge mode and continue acquiring GC/MS data.

7.3.5.4 Allow the trap to cool for 8 min. Replace the purging chamber with a clean purging chamber. The purging chamber is cleaned after each use by sequential washing with acetone, methanol, detergent solution and distilled water, and then dried at 105° C.

7.3.5.5 Close the syringe valve on the purging chamber after 15 sec to begin gas flow through the trap. Purge the trap at ambient temperature for 4 min. Recondition the trap by heating it to 180° C. Do not allow the trap temperature to exceed 180° C, since the sorption/desorption is adversely affected when the trap is heated to higher temperatures. After heating the trap for approximately 7 min, turn off the trap heater. When cool, the trap is ready for the next sample.

7.3.6 If the response for any ion exceeds the working range of the system, repeat the analysis using a correspondingly smaller aliquot of the sample extract described in Section 7.3.2.3.

7.4 Qualitative identification

7.4.1 Obtain an EICP for the primary characteristic ion and at least two other characteristic ions for each compound when practical. The following criteria must be met to make a qualitative identification.

7.4.1.1 The characteristic ions of each compound of interest must maximize in the same or within one scan of each other.

7.4.1.2 The retention time must fall within ± 30 sec of the retention time of the authentic compound.

7.4.1.3 The relative peak heights of the characteristic ions in the EICP's must fall within $\pm 20\%$ of the relative intensities of these ions in a reference mass spectrum. Reference spectra may be generated from the standards analyzed by the analyst or from a reference library. All reference spectra generated from standards must be obtained from an appropriately tuned mass spectrometer.

7.5 Quantitative determination

7.5.1 When a compound has been identified, the quantification of that compound will be based on the integrated abundance from the EICP of the primary characteristic ion. In general, the primary characteristic ion selected should be a relatively intense ion, as interference-free as possible, and as close as possible in mass to the characteristic ion of the internal standard used. Generally, the base peak of the mass spectrum is used.

8.0 Quality Control

8.1 Each laboratory that uses this method is required to operate a formal quality control program. The minimum requirements of this program consist of an initial demonstration of laboratory capability and the analysis of spiked samples as a continuing check on performance. The laboratory is required to maintain performance records to define the quality of the data that are generated. Ongoing performance checks must be compared with established performance criteria to determine if the results of analyses are within the accuracy and precision limits expected of the method.

8.1.1 Before performing any analyses, the analyst must demonstrate the ability to generate acceptable accuracy and precision with this method. This ability is established as described in Section 8.2.

8.1.2 The laboratory must spike all samples including check samples with surrogate standards to monitor continuing laboratory performance. This procedure is described in Section 8.4.

8.1.3 Before processing any samples, the analyst should daily demonstrate, through the analysis of an organic-free water method blank, that the entire analytical system is interference-free. The blank samples should be carried through all stages of the sample preparation and measurement steps.

8.2 To establish the ability to generate acceptable accuracy and precision, the analyst must perform the following operations using a representative sample as a check sample.

20 / ORGANIC ANALYTICAL METHODS - GC/MS

8.2.1 Analyze four aliquots of the unspiked check sample according to the method in Section 7.3.

8.2.2 For each compound to be measured, select a spike concentration representative of twice the level found in the unspiked check sample or a level equal to 10 times the expected detection limit, whichever is greater. Prepare a spiking solution by dissolving the compounds in methanol at the appropriate levels.

8.2.3 Spike a minimum of four aliquots of the check sample with the spiking solution to achieve the selected spike concentrations. Spike the samples by adding the spiking solution to the PEG used for the extraction. Analyze the spiked aliquots according to the method in Section 7.3.

8.2.4 Calculate the average percent recovery, R , and the standard deviation of the percent recovery, s , for all compounds and surrogate standards. Background corrections must be made before R and s calculations are performed. The average percent recovery must be greater than 20 for all compounds to be measured and greater than 60 for all surrogate compounds. The percent relative standard deviation of the percent recovery, $s/R \times 100$, must be less than 20 for all compounds to be measured and all surrogate compounds.

8.3 The analyst must calculate method performance criteria for each of the surrogate standards.

8.3.1 Calculate upper and lower control limits for method performance for each surrogate standard, using the values for R and s calculated in Section 8.2.4:

$$\text{Upper Control Limit (UCL)} = R + 3s$$

$$\text{Lower Control Limit (LCL)} = R - 3s$$

The UCL and LCL can be used to construct control charts that are useful in observing trends in performance.

8.3.2 For each surrogate standard, the laboratory must maintain a record of the R and s values obtained for each surrogate standard in each waste sample analyzed. An accuracy statement should be prepared from these data and updated regularly.

8.4 The laboratory is required to spike all samples with the surrogate standards to monitor spike recoveries. The spiking level used should be that which will give an amount in the purge apparatus that is equal to the amount of the internal standard assuming a 100% recovery of the surrogate standards. If the recovery for any surrogate standard does not fall within the control limits for method performance, the results reported for that sample must be

qualified as being outside of control limits. The laboratory must monitor the frequency of data so qualified to ensure that it remains at or below 5%. Four surrogate standards, namely 1,2-dibromodifluoroethane, bis(perfluoroisopropyl) ether, fluorobenzene, and m-bromobenzotrifluoride, are recommended for general use to monitor recovery of volatile compounds varying in volatility and polarity.

8.5 Each day, the analyst must demonstrate through the analysis of a process blank that all glassware and reagent interferences are under control.

8.6 It is recommended that the laboratory adopt additional quality assurance practices for use with this method. The specific practices that are most productive depend upon the needs of the laboratory and the nature of the samples. Field replicates may be analyzed to monitor the precision of the sampling technique. Whenever possible, the laboratory should perform analysis of standard reference materials and participate in relevant performance evaluation studies.

8.7 Standard quality assurance practices should be used with this method. Field replicates should be collected to validate the precision of the sampling technique. Laboratory replicates should be analyzed to validate the precision of the analysis. Fortified samples should be carried through all stages of sample preparation and measurement; they should be analyzed to validate the sensitivity and accuracy of the analysis. If the fortified waste samples do not indicate sufficient sensitivity to detect less than or equal to 1 µg/g of sample, then the sensitivity of the instrument should be increased or the extract subjected to additional cleanup. Detection limits to be used for groundwater samples are indicated in Table 1. Where doubt exists over the identification of a peak on the chromatograph, confirmatory techniques such as mass spectroscopy should be used.

8.8 The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations listed in Table 1 were obtained using reagent water. Similar results were achieved using representative wastewaters. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

8.9 In a single laboratory, using reagent water and wastewaters spiked at or near background levels, the average recoveries presented in Table 3 were obtained. The standard deviation of the measurement in percent recovery is also included in Table 3.

TABLE 3. ACCURACY AND PRECISION FOR PURGEABLE ORGANICS

Parameter	Reagent Water		Wastewater	
	Average percent recovery	Standard deviation (%)	Average percent recovery	Standard deviation (%)
Benzene	99	9	98	10
Bromodichloromethane	102	12	103	10
Bromoform	104	14	105	16
Bromomethane	100	20	88	23
Carbon tetrachloride	102	16	104	15
Chlorobenzene	100	7	102	9
Chloroethane	97	22	103	31
2-Chloroethyl vinyl ether	101	13	95	17
Chloroform	101	10	101	12
Chloromethane	99	19	99	24
Dibromochloromethane	103	11	104	14
1,1-Dichloroethane	101	10	104	15
1,2-Dichloroethane	100	8	102	10
1,1-Dichloroethene	102	17	99	15
trans-1,2-Dichloroethene	99	12	101	10
1,2-Dichloropropane	102	8	103	12
cis-1,3-Dichloropropene	105	15	102	19
trans-1,3-Dichloropropene	104	11	100	18
Ethyl benzene	100	8	103	10
Methylene chloride	96	16	89	28
1,1,2,2-Tetrachloroethane	102	9	104	14
Tetrachloroethene	101	9	100	11
Toluene	101	9	98	14
1,1,1-Trichloroethane	101	11	102	16
1,1,2-Trichloroethane	101	10	104	15
Trichloroethene	101	9	100	12
Trichlorofluoromethane	103	11	107	19
Vinyl chloride	100	13	98	25

Samples were spiked between 10 and 1000 µg/l.

REFERENCE 27

Cyanide, Method 9010, UST-RD-PM-9-80

20091216

ANALYTICAL GROUP CODE: C70

CYANIDE, METHOD 9010

TAB XII, 8

Detection Limit: ¹⁰
20 ppb 7-31-86 G. Rao
gvc

(1)

Cyanide in aqueous samples is determined by colorimetry using a UV/VIS spectrometer.

(2)

The instrument is set up and calibrated according to the manufacturer's instructions. Calibration standards are prepared in the concentration range of 0 to 120 ppb. The instrument stores the absorbances and generates an internal calibration curve.

(3)

All standards are prepared fresh when samples are to be analyzed. All standards are subjected to the same distillation procedure as the samples. Matrix spike recoveries are determined at a concentration of 100 ppb. Verification standards are prepared at concentrations near 100 ppb. Often EPA QC check samples are used as verification standards.

(4)

Absorbances are determined at a fixed wavelength which is determined whenever a fresh batch of barbituric acid is prepared. A 100 ppb standard is analyzed in the "wavelength scan" mode. In this mode, absorbances for wavelengths between 500 and 600 nm are determined. The peak of the distribution is then chosen as the fixed wavelength for all measurements. The wavelength is typically very close to 578 nm.

LAST PAGE

Approved For Use:

G. Rao 6-16-86
Neil H. H. Rao 6-16-86

METHOD 9010

TOTAL AND AMENABLE CYANIDE

1.0 Scope and Application

1.1 Method 9010 is used to determine the concentration of inorganic cyanide in a waste or leachate. The method detects inorganic cyanides that are present as either simple soluble salts or complex radicals. It is used to determine values for both total cyanide and cyanide amenable to chlorination. Method 9010 does not determine the "reactive" cyanide content of wastes containing iron-cyanide complexes.

2.0 Summary of Method

2.1 The cyanide as hydrocyanic acid (HCN) is released from cyanide complexes by means of a reflux-distillation operation and absorbed in a scrubber containing sodium hydroxide solution. The cyanide ion in the absorbing solution is then determined colorimetrically.

2.2 In the colorimetric measurement, the cyanide is converted to cyanogen chloride (CNCI) by reaction with chloramine-T at a pH less than 8 without hydrolyzing to the cyanate. After the reaction is complete, color is formed on the addition of pyridine-barbituric acid reagent. The absorbance is read at 570 nm for pyridine-barbituric acid reagent. To obtain colors of comparable intensity, it is essential to have the same salt content in both the sample and the standards.

3.0 Interferences

3.1 Interferences are eliminated or reduced by using the distillation procedure described in Procedure 7.2.3, 7.2.4, and 7.2.5.

3.2 Sulfides adversely affect the colorimetric procedures. Samples that contain hydrogen sulfide, metal sulfides or other compounds that may produce hydrogen sulfide during the distillation should be distilled by the optional procedure described in procedure 7.2.3.

3.3. High results may be obtained for samples that contain nitrate and/or nitrite. During the distillation, nitrate and nitrite will form nitrous acid which will react with some organic compounds to form oximes. These compounds formed will decompose under test conditions to generate HCN. The interference of nitrate and nitrite is eliminated by pretreatment with sulfamic acid.

Revised 4/84

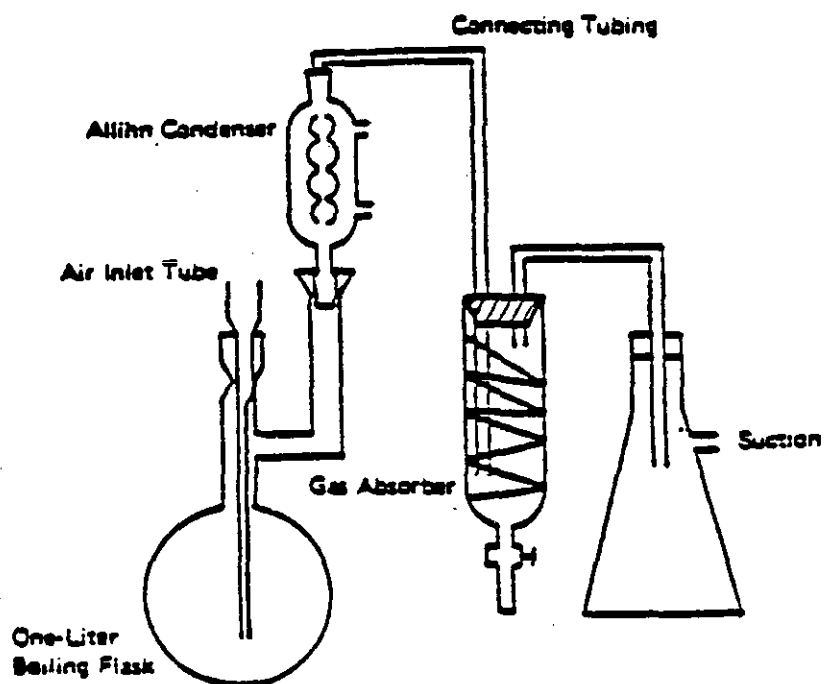


Figure 1. Apparatus for cyanide distillation.

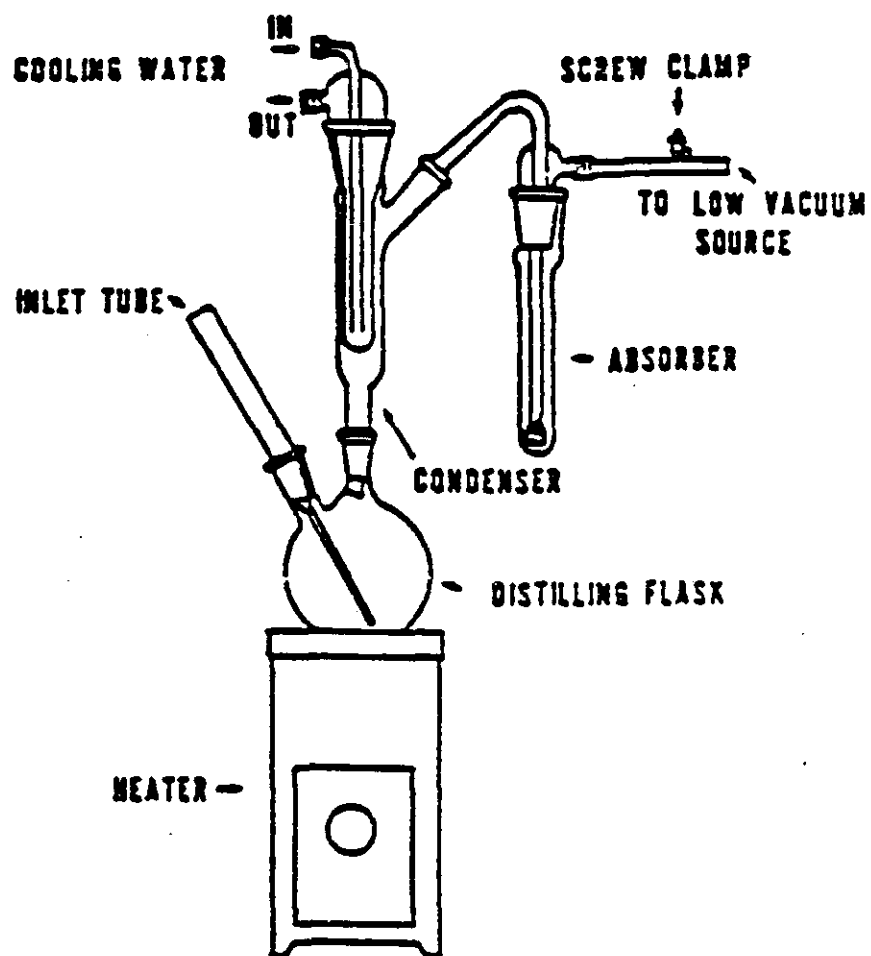


Figure 2. Cyanide distillation apparatus.

Revised 4/84

5.9 Sulfamic acid solution: Dissolve 40 g of sulfamic acid in distilled water. Dilute to 1 liter.

5.10 Calcium Hypochlorite solution: Dissolve 5 g of calcium hypochlorite ($\text{Ca}(\text{OCl})_2$) in 100 ml of distilled water.

5.11 Potassium Iodide-starch test paper.

5.12 Reagents for manual colorimetric determination:

5.12.1 Pyridine-Barbituric Acid Reagent: Place 15 g of barbituric acid in a 250 ml volumetric flask and add just enough distilled water to wash the sides of the flask and wet barbituric acid. Add 75 ml of pyridine and mix. Add 15 ml of conc. HCl, mix and cool to room temperature. Dilute to 250 ml with distilled water and mix. This reagent is stable for approximately six months if stored in a cool, dark place.

5.12.2 Chloramine-T solution: Dissolve 1.0 g of white, water soluble Chloramine-T in 100 ml of distilled water and refrigerate until ready to use.

5.13 Reagents for automated colorimetric determination:

5.13.1 Distillation agent: Carefully add 250 ml of 85% phosphoric acid and 50 ml of hypophosphorus acid to 700 ml of distilled water, mix, and dilute to one liter with distilled water.

5.13.2 Sodium dihydrogenphosphate, 1M (phosphate buffer): Dissolve 138 g of $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ in 1 liter of distilled water. Refrigerate this solution.

5.13.3 Chloramine-T: Dissolve 3.0 g of chloramine-T in 500 ml of distilled water.

5.13.4 Pyridine barbituric acid reagent: Refer to (5.12.1).

5.13.5 Sodium hydroxide, 1 N: Dissolve 40 g of NaOH in 500 ml of distilled water.

5.13.6 Stock cyanide solution: Refer to 5.5.

5.13.7 All working standards should contain 2 ml of 1 N NaOH (5.13.5) per 100 ml.

5.13.8 Dilution water and receptacle wash water (NaOH, 0.25 N): Dissolve 10.0 g NaOH in 500 mls of distilled water. Dilute to 1 liter.

4.0 Apparatus

4.1 Reflux distillation apparatus such as shown in Figure 1 or 2. The boiling flask should be of 1 liter size with inlet tube and provision for condenser. The gas absorber may be a Fisher-Milligan scrubber.

4.2 Spectrophotometer suitable for measurements \pm 570 nm with a 1.0 cm cell or larger.

4.3 Flow meter, such as Lab Crest with stainless steel float (Fisher 11-164-50).

4.4 Technicon Auto-Analyzer

4.4.1 Sampler

4.4.2 Cyanide manifold. (See Figure 3.)

4.4.3 Proportioning pump.

4.4.4 Colorimeter equipped with a 15 mm flowcell and 570 nm filter.

4.4.5 Recorder.

5.0 Reagents

5.1 Sodium hydroxide solution, 1.25N: Dissolve 50 g of NaOH in distilled water, and dilute to 1 liter with distilled water.

5.2 Bismuth nitrate solution: Dissolve 30.0 grams of $\text{Bi}(\text{NO}_3)_3$ in 100 ml of distilled water. While stirring, add 250 ml of acetic acid. Stir until dissolved. Dilute to 1 liter with distilled water.

5.3 Sulfuric acid; 18N: Slowly add 500 ml of concentrated H_2SO_4 to 500 ml of distilled water.

5.4 Sodium dihydrogenphosphate, 1 M: Dissolve 138 g of $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ in 1 liter of distilled water. Refrigerate this solution.

5.5 Stock cyanide solution: Dissolve 2.51 g of KCN and 2 g KOH in 900 ml of distilled water. Standardize with 0.0192 N AgNO_3 . Dilute to appropriate concentration so that 1 ml = 1 mg CN.

5.6 Standard cyanide solution, intermediate: Dilute 100.0 ml of stock (1 ml = 1 mg CN) to 1000 ml with distilled water (1 ml = 100 g).

5.7 Working standard cyanide solution: Prepare fresh daily by diluting 100.0 ml of intermediate cyanide solution to 1000 ml with distilled water and store in a glass stoppered bottle. 1 ml = 10.0 ug CN.

5.8 Magnesium chloride solution: Weigh 510 g of $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ into a 1000 ml flask, dissolve and dilute to 1 liter with distilled water.

Revised 4/84

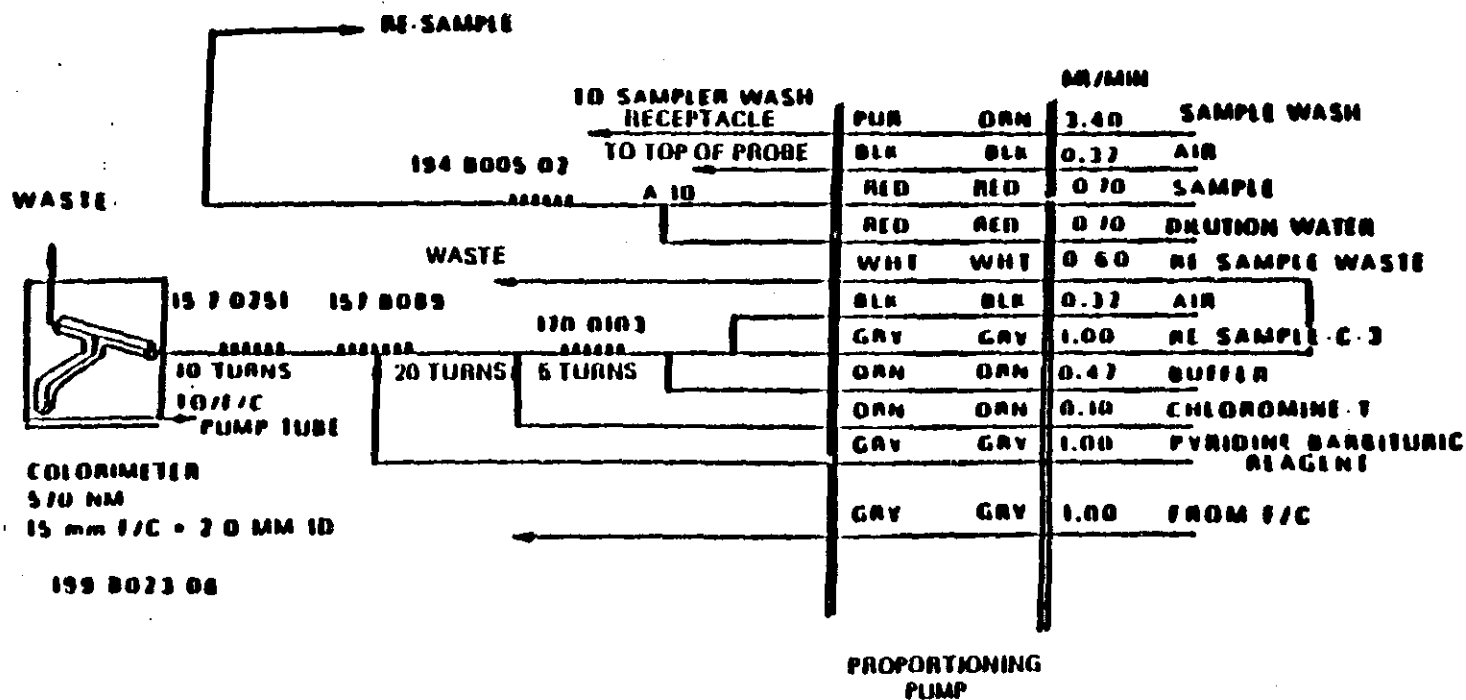


Figure 3. Cyanide manifold AA11.

6.0 Sample Collection, Preservation and Handling

6.1 All samples must have been collected using a sampling plan that addresses the considerations discussed in Section One of this manual.

6.2 Samples should be collected in plastic or glass bottles of 1-liter size or larger. All bottles must be thoroughly cleaned and thoroughly rinsed to remove soluble materials from containers.

6.3 Oxidizing agents such as chlorine decompose most cyanides. To determine whether oxidizing agents are present, test a drop of the sample with potassium iodide-starch test paper; a blue color indicates the need for treatment. Add ascorbic acid a few crystals at a time until a drop of sample produces no color on the indicator paper. Then add an additional 0.6 g of ascorbic acid for each liter of water.

6.4 Samples must be preserved with 2 ml of 10 N sodium hydroxide per liter of sample (pH is greater than or equal to 12) at the time of collection.

6.5 Samples should be refrigerated at 4°C when possible and analyzed as soon as possible.

7.0 Procedure

7.1 Pretreatment for cyanides amenable to chlorination

7.1.1 Two sample aliquots are required to determine cyanides amenable to chlorination. To one 500 ml aliquot or a volume diluted to 500 ml, add calcium hypochlorite solution (5.10) dropwise while agitating and maintaining the pH between 11 and 12 with sodium hydroxide (5.1).

Caution: The initial reaction product of alkaline chlorination is the very toxic gas cyanogen chloride; therefore, it is recommended that this reaction be performed in a hood. For convenience, the sample may be agitated in a 1 liter beaker by means of a magnetic stirring device.

7.1.2 Test for residual chlorine with KI-starch paper (5.11) and maintain this excess for one hour, continuing agitation. A distinct blue color on the test paper indicates a sufficient chlorine level. If necessary, add additional hypochlorite solution.

7.1.3 After one hour, add 0.5 g portions of ascorbic acid until KI-starch paper shows no residual chlorine. Add an additional 0.5 g of ascorbic acid to ensure the presence of excess reducing agent.

7.1.4 Test for total cyanide in both the chlorinated and unchlorinated aliquots. (The difference of total cyanide in the chlorinated and unchlorinated aliquots is the cyanide amenable to chlorination.)

Revised 4/84

7.2 Distillation Procedure

7.2.1 Place 500 ml of sample, or an aliquot diluted to 500 ml in the 1 liter boiling flask. Pipet 50 ml of sodium hydroxide (5.1) into the absorbing tube. If the apparatus in Figure 1 is used, add distilled water until the spiral is covered. Connect the boiling flask, condenser, absorber and trap in the train. (Figure 1 or 2)

7.2.2 Start a slow stream of air entering the boiling flask by adjusting the vacuum source. Adjust the vacuum so that approximately two bubbles of air per second enters the boiling flask through the air inlet tube.

7.2.3 If samples contain sulfide, add 50 ml of bismuth nitrate solution (5.2) after the air rate is set through the air inlet tube. Mix for 3 minutes prior to addition of H_2SO_4 .

7.2.4 If samples contain NO_3 and/or NO_2 , add 50 ml of sulfamic acid solution (5.9) after the air rate is set through the air inlet tube. Mix for 3 minutes prior to addition of H_2SO_4 .

7.2.5 Slowly add 50 ml 18 N sulfuric acid (5.3) through the air inlet tube. Rinse the tube with distilled water and allow the airflow to mix the flask contents for 3 minutes. Pour 20 ml of magnesium chloride (5.8) into the air inlet and wash down with a stream of water.

7.2.6 Heat the solution to boiling. Reflux for one hour. Turn off heat and continue the airflow for at least 15 minutes. After cooling the boiling flask, disconnect absorber and close off the vacuum source.

7.2.7 Drain the solution from the absorber into a 250 ml volumetric flask. Wash the absorber with distilled water and add the washings to the flask. Dilute to the mark with distilled water.

7.3 Manual spectrophotometric determination:

7.3.1 Withdraw 50 ml or less of the solution from the flask and transfer to a 100 ml volumetric flask. If less than 50 ml is taken, dilute to 50 ml with 0.25 N sodium hydroxide solution (5.13.8). Add 15.0 ml of sodium phosphate solution (5.4) and mix.

7.3.2 Add 2 ml of chloramine-T (5.12.2) and mix. See note 1. After 1 to 2 minutes, add 5 ml of pyridine-barbituric acid solution (5.12.1) and mix. Dilute to mark with distilled water and mix again. Allow 8 minutes for color development and then read absorbance at 570 nm in a 1-cm cell within 15 minutes.

7.4 Standard curve for samples without sulfide

7.4.1 Prepare a series of standards by pipeting suitable volumes of standard solution (5.7) into 250 ml volumetric flasks. To each standard add 50 ml of 1.25 N sodium hydroxide and dilute to 250 ml with distilled water. Prepare as follows:

<u>ML of Working Standard Solution</u> <u>(1 ml = 10 g CN)</u>	<u>Conc. g CN</u> <u>per 250 ml</u>
0	BLANK
1.0	10
2.0	20
5.0	50
10.0	100
15.0	150
20.0	200

7.4.2 It is not imperative that all standards be distilled in the same manner as the samples. It is recommended that at least two standards (a high and a low) be distilled and compared to similar values on the curve to insure that the distillation technique is reliable. If distilled standards do not agree within $\pm 10\%$ of the undistilled standards, the analyst should find the cause of the apparent error before proceeding.

7.4.3 Prepare a standard curve by plotting absorbance of standard vs. cyanide concentrations.

7.4.4 To check the efficiency of the sample distillation, add an increment of cyanide from either the intermediate standard (5.6) or the working standard (5.7) to 500 ml of sample to insure a level of 20 $\mu\text{g/l}$. Proceed with the analysis as in Procedure (7.2.1)

7.5 Standard curve for samples with sulfide

7.5.1 It is imperative that all standards be distilled in the same manner as the samples. Standards distilled by this method will give a linear curve, but as the concentration increases, the recovery decreases. It is recommended that at least 3 standards be distilled.

7.5.2 Prepare a standard curve by plotting absorbance of standards vs. cyanide concentrations.

7.6 Calculation: If the colormetric procedure is used, calculate the cyanide, in $\mu\text{g/l}$, in the original sample as follows:

$$\text{CN, } \mu\text{g/l} = \frac{A \times 1,000}{B} \times \frac{50}{C}$$

Revised 4/84

where:

A = μg CN read from standard curve
B = ml of original sample for distillation
C = ml taken for colorimetric analysis

7.7 Automated colorimetric determination

7.7.1 Set up the manifold as shown in Figure 3 in a hood or a well ventilated area.

7.7.2 Allow colorimeter and recorder to warm up for 30 minutes. Run a baseline with all reagents, feeding distilled water through the sample line.

7.7.3 Place appropriate standards in the sampler in order of decreasing concentration. Complete loading of sampler tray with unknown samples.

7.7.4 When the baseline becomes steady, begin the analyses.

7.8 Calculation: Prepare standard curve by plotting peak heights of standards against concentration values. Compute concentrations of samples by comparing sample peak heights with standards.

8.0 Quality Control

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 Employ a minimum of one blank per sample batch to determine if contamination or any memory effects are occurring.

8.3 Analyze check standards after approximately every 15 samples.

8.4 Run one duplicate sample for every 10 samples. A duplicate sample is a sample brought through the whole sample preparation process.

8.5 Spiked samples or standard reference materials shall be periodically employed to ensure that correct procedures are being followed and that all equipment is operating properly.

8.6 The method of standard additions shall be used for the analysis of all samples that suffer from matrix interferences.

REFERENCE 28

Drawing H-3-53734 (Showing 300 Area River Intake)

300
Area
River
Intake

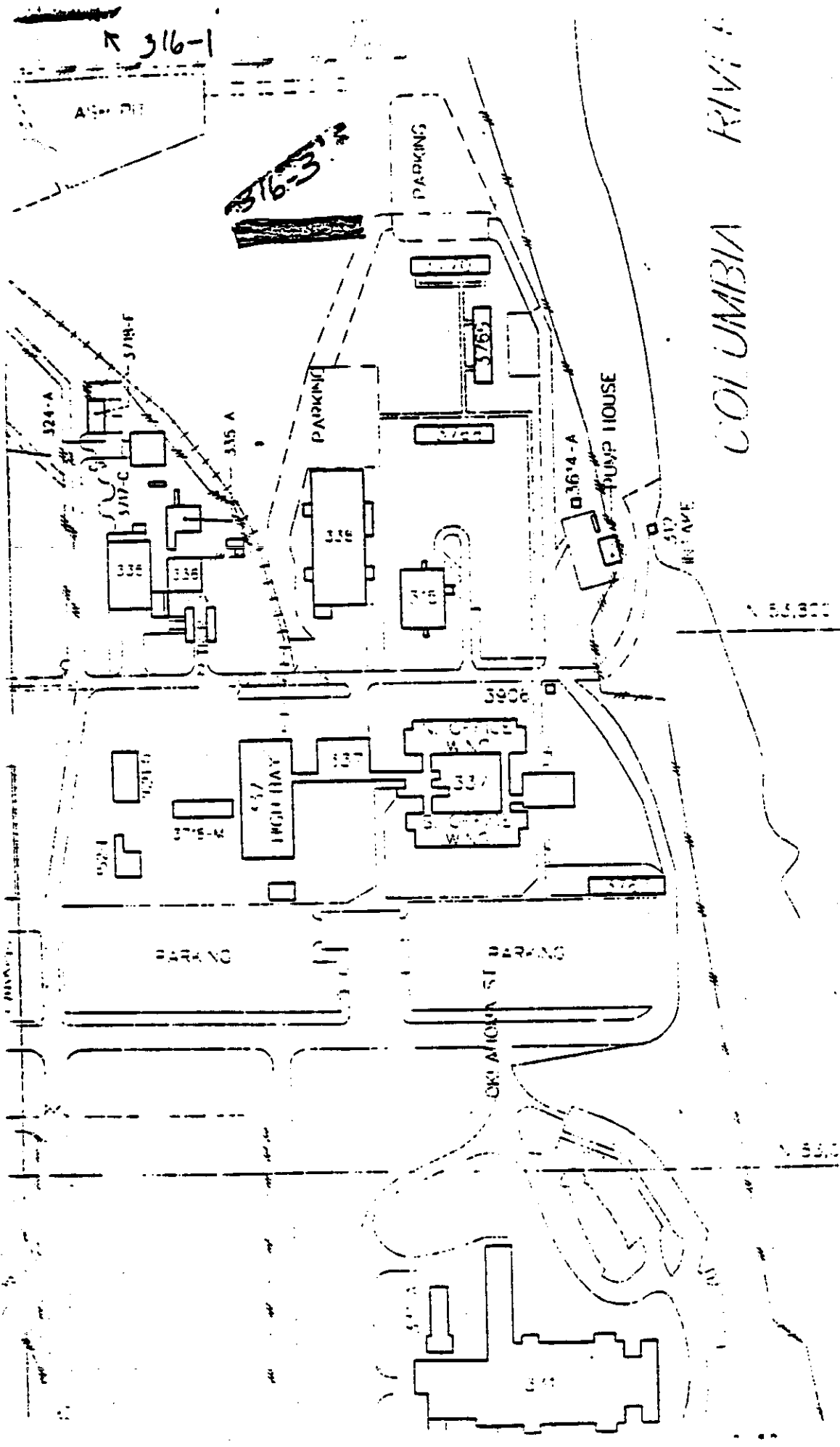
943218.0636

316-1

316-3

1955-7
WV-5-1

COLUMBIA RIVER



REFERENCE 29

Memo to file from WS Weygandt concerning Personal
Communication with RB Hall Regarding the 312 River Water
Intake for 300 Area, August 13, 1987

943210.127
6907616



Battelle

Pacific Northwest Laboratories

Project Number _____

Internal Distribution

File/LB

Date August 13, 1987

To File

From W. S. Weygandt *WSW*

Subject 312 Water Intake

A telephone conversation with R. B. Hall of WHC revealed that the 300 Area gets all of its water from the Columbia River through the 312 intake. The 300 Area is connected to the Richland city water supply, but this is only used during emergencies.

WSW:cs

REFERENCE 30

Database Printouts of Surface Water Sample Points

9403218.069

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REPORT

21 DEC 82 to 15 MAR 83

WATER

RIVER WATER

CUMULATIVE

UNFILTERED

Samp #: 1265

PRIEST RAPIDS-RIVER

208/LO H 3

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
21 DEC 82	23 NOV 82	1.68E+02 +/- 1.40E+01	
18 JAN 83	21 DEC 82	1.20E+02 +/- 1.36E+01	BKG
15 FEB 83	18 JAN 83	1.35E+02 +/- 1.47E+01	
15 MAR 83	15 FEB 83	1.28E+02 +/- 1.41E+01	BKG

Fraction of Results > DL: 4/ 4 Mean: 1.38E+02
Minimum: 1.20E+02 (18 JAN 83) Standard Error of Mean: 2.44E+01
Maximum: 1.68E+02 (21 DEC 82) Standard Deviation: 4.87E+01
Median: 1.28E+02

13-AUG-87

Page 1

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REPORT

18 JAN 83 to 20 DEC 83

WATER

RIVER WATER

CUMULATIVE

UNFILTERED

Samp #: 1000

RICHLAND PUMP HOUSE

208/L0 H 3

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
18 JAN 83	05 JAN 83	9.07E+01 +/- 1.34E+01	(6)
15 FEB 83	18 JAN 83	1.18E+02 +/- 1.36E+01	
15 MAR 83	15 FEB 83	1.34E+02 +/- 1.40E+01	
12 APR 83	22 MAR 83	1.94E+02 +/- 1.53E+01	
10 MAY 83	12 APR 83	1.49E+02 +/- 2.06E+01	
07 JUN 83	10 MAY 83	1.63E+02 +/- 2.09E+01	
05 JUL 83	07 JUN 83	1.09E+02 +/- 1.74E+01	
02 AUG 83	05 JUL 83	2.36E+02 +/- 2.07E+01	DG
30 AUG 83	02 AUG 83	1.51E+02 +/- 1.49E+01	
27 SEP 83	30 AUG 83	1.55E+02 +/- 1.44E+01	
25 OCT 83	27 SEP 83	1.33E+02 +/- 1.45E+01	
22 NOV 83	25 OCT 83	3.93E+01 +/- 1.22E+01	95
20 DEC 83	22 NOV 83	7.81E+01 +/- 1.27E+01	9

Fraction of Results > DL: 13/ 13 Mean: 1.35E+02
Minimum: 3.93E+01 (22 NOV 83) Standard Error of Mean: 2.84E+01
Maximum: 2.36E+02 (02 AUG 83) Standard Deviation: 1.02E+02
Median: 1.34E+02

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REPORT

28 JAN 86 to 30 DEC 86

WATER

RIVER WATER

CUMULATIVE

UNFILTERED

Samp #: 1265

PRIEST RAPIDS-RIVER

208/LO H 3

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
28 JAN 86	31 DEC 85	1.02E+02 +/- 1.06E+01	
25 FEB 86	28 JAN 86	1.30E+02 +/- 1.11E+01	
01 APR 86	25 FEB 86	1.05E+02 +/- 1.03E+01	BKG
29 APR 86	01 APR 86	1.19E+02 +/- 1.10E+01	
03 JUN 86	29 APR 86	9.87E+01 +/- 1.03E+01	
01 JUL 86	03 JUN 86	6.12E+01 +/- 7.07E+00	BKG
29 JUL 86	01 JUL 86	6.12E+01 +/- 7.06E+00	
02 SEP 86	29 JUL 86	1.06E+02 +/- 8.19E+00	
30 SEP 86	02 SEP 86	8.98E+01 +/- 7.46E+00	
28 OCT 86	30 SEP 86	1.16E+02 +/- 9.04E+00	
02 DEC 86	28 OCT 86	1.04E+02 +/- 8.29E+00	
30 DEC 86	02 DEC 86	8.83E+01 +/- 7.52E+00	

Fraction of Results > DL: 12/ 12 Mean: 9.84E+01
 Minimum: 6.12E+01 (01 JUL 86) Standard Error of Mean: 1.24E+01
 Maximum: 1.30E+02 (25 FEB 86) Standard Deviation: 4.29E+01
 Median: 1.02E+02

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REPORT

28 JAN 86 to 30 DEC 86

WATER

RIVER WATER

CUMULATIVE

UNFILTERED

Samp #: 1000

RICHLAND PUMP HOUSE

208/LO H 3

Date Off	Date On	Result +/- 2 Sigma (PCI/L)		Comments
28 JAN 86	31 DEC 85	2.09E+02 +/-	1.27E+01	
25 FEB 86	28 JAN 86	2.06E+02 +/-	1.30E+01	D6 (1)
01 APR 86	25 FEB 86	1.10E+02 +/-	1.05E+01	
29 APR 86	01 APR 86	1.28E+02 +/-	1.08E+01	
03 JUN 86	29 APR 86	1.25E+02 +/-	1.09E+01	
01 JUL 86	03 JUN 86	1.38E+02 +/-	8.37E+00	
29 JUL 86	01 JUL 86	1.53E+02 +/-	9.17E+00	
02 SEP 86	29 JUL 86	1.59E+02 +/-	8.29E+00	
30 SEP 86	02 SEP 86	1.54E+02 +/-	8.23E+00	
28 OCT 86	30 SEP 86	1.48E+02 +/-	8.20E+00	
02 DEC 86	28 OCT 86	1.34E+02 +/-	8.48E+00	
30 DEC 86	02 DEC 86	1.26E+02 +/-	8.09E+00	

Fraction of Results > DL: 12/ 12 Mean: 1.49E+02
Minimum: 1.10E+02 (01 APR 86) Standard Error of Mean: 1.80E+01
Maximum: 2.09E+02 (28 JAN 86) Standard Deviation: 5.23E+01
Median: 1.38E+02

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REPORT

21 DEC 82 to 10 MAY 83

WATER

RIVER WATER

CONT.-RESIN

Samp #: 4394

PRIEST RAPIDS-RIVER

081/I 129

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
21 DEC 82	23 NOV 82	5.20E-06 +/- 8.32E-07	BKG (5)
15 FEB 83	21 DEC 82	2.80E-05 +/- 2.24E-05	
10 MAY 83	15 FEB 83	3.79E-05 +/- 4.09E-06	

Fraction of Results > DL: . 3/ 3 Mean: 2.37E-05
Minimum: 5.20E-06 (21 DEC 82) Standard Error of Mean: 2.36E-05
Maximum: 3.79E-05 (10 MAY 83) Standard Deviation: 4.08E-05
Median: 2.80E-05

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REPORT

15 FEB 83 to 25 OCT 83

WATER

RIVER WATER

CONT.-RESIN

Samp #: 6384

300 AREA-RIVER

081/I 129

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
15 FEB 83	21 DEC 82	6.80E-05 +/- 4.08E-06	
10 MAY 83	15 FEB 83	3.91E-05 +/- 4.14E-06	
29 JUL 83	10 MAY 83	7.47E-05 +/- 7.62E-06	
25 OCT 83	29 JUL 83	1.20E-04 +/- 1.22E-05	DG

Fraction of Results > DL: 4/ 4 Mean: 7.54E-05
Minimum: 3.91E-05 (10 MAY 83) Standard Error of Mean: 3.94E-05
Maximum: 1.20E-04 (25 OCT 83) Standard Deviation: 7.87E-05
Median: 6.80E-05

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REPORT

25 MAR 86 to 30 DEC 86

WATER

RIVER WATER

CONT.-RESIN

Samp #: 6394

PRIEST RAPIDS-RIVER

081/I 129

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
25 MAR 86	31 DEC 85	8.10E-06 +/- 8.91E-07	
01 JUL 86	25 MAR 86	8.20E-06 +/- 7.87E-07	
07 OCT 86	01 JUL 86	1.04E-05 +/- 1.29E-06	
30 DEC 86	07 OCT 86	7.60E-06 +/- 9.42E-07	BKG

Fraction of Results > DL: 4/ 4 Mean: 8.58E-06
Minimum: 7.60E-06 (30 DEC 86) Standard Error of Mean: 1.45E-06
Maximum: 1.04E-05 (07 OCT 86) Standard Deviation: 2.90E-06
Median: 8.10E-06

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REPORT

25 MAR 86 to 30 DEC 86

WATER

RIVER WATER

CONT.-RESIN

Samp #: 6384

300 AREA-RIVER

081/I 129

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
25 MAR 86	31 DEC 85	7.93E-05 +/- 7.30E-06	
01 JUL 86	25 MAR 86	8.98E-05 +/- 8.08E-06	
07 OCT 86	01 JUL 86	1.61E-04 +/- 1.45E-05	06
30 DEC 86	07 OCT 86	7.87E-05 +/- 7.24E-06	

Fraction of Results > DL: 4/ 4 Mean: 1.02E-04
Minimum: 7.87E-05 (30 DEC 86) Standard Error of Mean: 4.03E-05
Maximum: 1.61E-04 (07 OCT 86) Standard Deviation: 8.06E-05
Median: 7.93E-05

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REP

09 JAN 82 to 28 JUL 87

WATER
Samp # 1265RIVER WATER
PRIEST RAPIDS-RIVER

CUMULATIVE

UNFILTERED

208/LD H 3

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
09 JAN 82	02 JAN 81	1.59E+02 +/- 2.00E+01	
22 JAN 82	15 JAN 82	2.41E+02 +/- 1.40E+01	
19 FEB 82	12 FEB 82	3.25E+02 +/- 1.80E+01	
02 MAR 82		1.55E+02 +/- 2.00E+01	
16 MAR 82		3.06E+02 +/- 2.00E+01	
30 MAR 82		3.04E+02 +/- 2.00E+01	
13 APR 82		8.90E+01 +/- 2.00E+01	
27 APR 82	20 APR 82	1.06E+02 +/- 2.00E+01	
11 MAY 82	27 APR 82	1.36E+02 +/- 1.40E+01	
18 MAY 82	11 MAY 82	7.10E+01 +/- 1.80E+01	
08 JUN 82	26 MAY 82	1.25E+02 +/- 1.40E+01	
06 JUL 82	29 JUN 82	1.17E+02 +/- 1.40E+01	
03 AUG 82	13 JUL 82	1.45E+02 +/- 1.40E+01	
31 AUG 82	23 AUG 82	8.60E+01 +/- 1.40E+01	
28 SEP 82	21 SEP 82	7.70E+01 +/- 1.50E+01	
26 OCT 82	20 SEP 82	1.28E+02 +/- 1.20E+01	
23 NOV 82	24 SEP 82	1.21E+02 +/- 1.20E+01	
21 DEC 82	23 NOV 82	1.68E+02 +/- 1.40E+01	
18 JAN 83	21 DEC 82	1.20E+02 +/- 1.36E+01	
15 FEB 83	18 JAN 83	1.35E+02 +/- 1.47E+01	
15 MAR 83	15 FEB 83	1.28E+02 +/- 1.41E+01	
12 APR 83	15 MAR 83	1.23E+02 +/- 1.53E+01	
10 MAY 83	12 APR 83	7.50E+01 +/- 1.58E+01	
07 JUN 83	10 MAY 83	1.20E+02 +/- 1.19E+01	
05 JUL 83	07 JUN 83	6.53E+01 +/- 1.26E+01	
02 AUG 83	05 JUL 83	2.02E+02 +/- 2.15E+01	
30 AUG 83	02 AUG 83	1.44E+02 +/- 2.09E+01	
27 SEP 83	30 AUG 83	7.54E+01 +/- 1.38E+01	
25 OCT 83	27 SEP 83	5.73E+01 +/- 1.36E+01	
22 NOV 83	25 OCT 83	3.95E+01 +/- 1.12E+01	BKG
20 DEC 83	22 NOV 83	5.88E+01 +/- 1.19E+01	
17 JAN 84	20 DEC 83	1.03E+02 +/- 1.10E+01	
14 FEB 84	17 JAN 84	1.11E+02 +/- 1.11E+01	
13 MAR 84	14 FEB 84	1.29E+02 +/- 1.23E+01	
10 APR 84	13 MAR 84	1.66E+02 +/- 9.40E+00	
08 MAY 84	10 APR 84	1.19E+02 +/- 1.07E+01	
05 JUN 84	08 MAY 84	1.37E+02 +/- 1.07E+01	
03 JUL 84	05 JUN 84	1.05E+02 +/- 8.80E+00	
31 JUL 84	03 JUL 84	1.32E+02 +/- 1.00E+01	
28 AUG 84	31 JUL 84	9.40E+01 +/- 9.40E+00	
25 SEP 84	28 AUG 84	1.19E+02 +/- 1.16E+01	
23 OCT 84	25 SEP 84	1.29E+02 +/- 1.22E+01	
20 NOV 84	23 OCT 84	1.13E+02 +/- 1.27E+01	

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REP

09 JAN 82 to 28 JUL 87

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
18 DEC 84	20 NOV 84	1.90E+02 +/- 1.37E+01	
29 JAN 85	02 JAN 85	1.55E+02 +/- 1.31E+01	(1)
26 FEB 85	29 JAN 85	1.48E+02 +/- 1.19E+01	
02 APR 85	26 FEB 85	1.05E+02 +/- 1.33E+01	
30 APR 85	02 APR 85	6.37E+01 +/- 1.12E+01	←
24 MAY 85	30 APR 85	8.48E+01 +/- 1.20E+01	
02 JUL 85	24 MAY 85	8.75E+01 +/- 1.09E+01	
30 JUL 85	02 JUL 85	8.58E+01 +/- 1.09E+01	
03 SEP 85	30 JUL 85	8.88E+01 +/- 1.07E+01	
01 OCT 85	03 SEP 85	1.17E+02 +/- 1.13E+01	
29 OCT 85	01 OCT 85	1.29E+02 +/- 1.09E+01	
03 DEC 85	29 OCT 85	1.32E+02 +/- 1.20E+01	
31 DEC 85	03 DEC 85	1.43E+02 +/- 1.23E+01	
28 JAN 86	31 DEC 85	1.02E+02 +/- 1.06E+01	
25 FEB 86	28 JAN 86	1.30E+02 +/- 1.11E+01	
01 APR 86	25 FEB 86	1.05E+02 +/- 1.03E+01	
29 APR 86	01 APR 86	1.19E+02 +/- 1.10E+01	
03 JUN 86	29 APR 86	9.87E+01 +/- 1.03E+01	
01 JUL 86	03 JUN 86	6.12E+01 +/- 7.07E+00	
29 JUL 86	01 JUL 86	6.12E+01 +/- 7.06E+00	
02 SEP 86	29 JUL 86	1.06E+02 +/- 8.19E+00	
30 SEP 86	02 SEP 86	8.98E+01 +/- 7.46E+00	
28 OCT 86	30 SEP 86	1.16E+02 +/- 9.04E+00	
02 DEC 86	28 OCT 86	1.04E+02 +/- 8.29E+00	
30 DEC 86	02 DEC 86	8.83E+01 +/- 7.52E+00	
03 FEB 87	30 DEC 86	7.62E+01 +/- 9.19E+00	
03 MAR 87	03 FEB 87	6.76E+01 +/- 9.39E+00	
31 MAR 87	03 MAR 87	5.37E+01 +/- 8.83E+00	↘
28 APR 87	31 MAR 87	1.07E+02 +/- 5.80E+00	
02 JUN 87	28 APR 87	9.40E+01 +/- 8.04E+00	
30 JUN 87	02 JUN 87	7.13E+01 +/- 5.17E+00	
28 JUL 87	30 JUN 87	7.09E+01 +/- 5.26E+00	

Fraction of Results > DLI 75/ 75 Mean: 1.19E+02
 Minimum: 3.95E+01 (22 NOV 83) Standard Error of Mean: 1.24E+01
 Maximum: 3.25E+02 (19 FEB 82) Standard Deviation: 1.08E+02
 Median: 1.13E+02

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REP

09 JAN 82 to 28 JUL 87

WATER
Samp #1 1000RIVER WATER
RICHLAND PUMP HOUSE

CUMULATIVE

UNFILTERED

208/L0 H 3

Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
09 JAN 82	02 JAN 82	2.06E+02 +/- 1.60E+01	
22 JAN 82	15 JAN 82	2.19E+02 +/- 2.00E+01	
05 FEB 82	29 JAN 82	3.57E+02 +/- 1.60E+01	
19 FEB 82	12 FEB 82	6.68E+02 +/- 2.20E+01	
02 MAR 82		2.80E+02 +/- 2.00E+01	
16 MAR 82		3.30E+02 +/- 2.00E+01	
30 MAR 82		2.86E+02 +/- 2.00E+01	
13 APR 82	30 MAR 82	1.78E+02 +/- 2.00E+01	
27 APR 82	20 APR 82	1.57E+02 +/- 2.00E+01	
12 MAY 82		1.34E+02 +/- 2.00E+01	
18 MAY 82	11 MAY 82	1.12E+02 +/- 2.00E+01	
08 JUN 82		1.53E+02 +/- 1.60E+01	
29 JUN 82	12 JUN 82	1.00E+02 +/- 1.40E+01	
03 AUG 82	13 JUL 82	1.54E+02 +/- 1.40E+01	
31 AUG 82	03 AUG 82	1.49E+02 +/- 1.40E+01	
21 SEP 82	31 AUG 82	1.20E+02 +/- 1.50E+01	
26 OCT 82	21 SEP 82	1.51E+02 +/- 1.40E+01	
23 NOV 82	26 OCT 82	2.17E+02 +/- 1.40E+01	
07 DEC 82	23 NOV 82	1.42E+02 +/- 1.40E+01	
18 JAN 83	05 JAN 83	9.07E+01 +/- 1.34E+01	(2)
15 FEB 83	1A JAN 83	1.18E+02 +/- 1.36E+01	
15 MAR 83	15 FEB 83	1.34E+02 +/- 1.40E+01	
12 APR 83	22 MAR 83	1.94E+02 +/- 1.53E+01	
10 MAY 83	12 APR 83	1.49E+02 +/- 2.06E+01	
07 JUN 83	10 MAY 83	1.63E+02 +/- 2.09E+01	
05 JUL 83	07 JUN 83	1.09E+02 +/- 1.74E+01	
02 AUG 83	05 JUL 83	2.36E+02 +/- 2.07E+01	DG
30 AUG 83	02 AUG 83	1.51E+02 +/- 1.49E+01	
27 SEP 83	30 AUG 83	1.55E+02 +/- 1.44E+01	
25 OCT 83	27 SEP 83	1.33E+02 +/- 1.45E+01	
22 NOV 83	25 OCT 83	3.93E+01 +/- 1.22E+01	2.32X B
20 DEC 83	22 NOV 83	7.81E+01 +/- 1.27E+01	
14 FEB 84	17 JAN 84	1.37E+02 +/- 1.23E+01	
13 MAR 84	14 FEB 84	1.50E+02 +/- 1.25E+01	
10 APR 84	13 MAR 84	2.00E+02 +/- 1.05E+01	
08 MAY 84	10 APR 84	1.56E+02 +/- 1.08E+01	
05 JUN 84	08 MAY 84	1.79E+02 +/- 1.11E+01	
03 JUL 84	05 JUN 84	1.59E+02 +/- 8.30E+00	
31 JUL 84	03 JUL 84	1.34E+02 +/- 1.00E+01	
28 AUG 84	31 JUL 84	1.44E+02 +/- 9.90E+00	
25 SEP 84	28 AUG 84	2.70E+02 +/- 1.39E+01	
23 OCT 84	25 SEP 84	1.76E+02 +/- 1.39E+01	
20 NOV 84	23 OCT 84	1.32E+02 +/- 1.26E+01	
18 DEC 84	20 NOV 84	1.85E+02 +/- 1.28E+01	

29-NOV-87

Version 1.0

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REP

Page

713210.165

09 JAN 82 to 28 JUL 87

Date Off	Date On	Result +/- 2 Sigma (PC/L)	Comments (3)
29 JAN 85	02 JAN 85	1.62E+02 +/- 1.36E+01	
19 FEB 85	29 JAN 85	1.47E+02 +/- 1.16E+01	
02 APR 85	26 FEB 85	1.64E+02 +/- 1.43E+01	
30 APR 85	02 APR 85	1.80E+02 +/- 1.35E+01	2.83X04
28 MAY 85	30 APR 85	9.42E+01 +/- 1.20E+01	
02 JUL 85	28 MAY 85	1.51E+02 +/- 1.24E+01	
30 JUL 85	02 JUL 85	1.72E+02 +/- 1.20E+01	
03 SEP 85	30 JUL 85	1.64E+02 +/- 1.21E+01	
01 OCT 85	03 SEP 85	9.94E+01 +/- 1.11E+01	
29 OCT 85	01 OCT 85	1.07E+02 +/- 1.03E+01	
03 DEC 85	29 OCT 85	1.67E+02 +/- 1.41E+01	
31 DEC 85	03 DEC 85	2.17E+02 +/- 1.33E+01	
28 JAN 86	31 DEC 85	2.09E+02 +/- 1.27E+01	
25 FEB 86	28 JAN 86	2.06E+02 +/- 1.30E+01	
01 APR 86	25 FEB 86	1.10E+02 +/- 1.05E+01	
29 APR 86	01 APR 86	1.28E+02 +/- 1.00E+01	
03 JUN 86	29 APR 86	1.25E+02 +/- 1.09E+01	
01 JUL 86	03 JUN 86	1.34E+02 +/- 8.37E+00	
29 JUL 86	01 JUL 86	1.53E+02 +/- 9.17E+00	
02 SEP 86	29 JUL 86	1.59E+02 +/- 8.29E+00	
30 SEP 86	02 SEP 86	1.54E+02 +/- 8.23E+00	
28 OCT 86	30 SEP 86	1.48E+02 +/- 8.20E+00	
02 DEC 86	28 OCT 86	1.34E+02 +/- 8.48E+00	
30 DEC 86	02 DEC 86	1.26E+02 +/- 8.09E+00	
03 FEB 87	30 DEC 86	1.43E+02 +/- 1.13E+01	
03 MAR 87	03 FEB 87	1.29E+02 +/- 1.02E+01	
31 MAR 87	03 MAR 87	1.27E+02 +/- 9.97E+00	2.36X04
28 APR 87	31 MAR 87	1.26E+02 +/- 5.59E+00	
02 JUN 87	28 APR 87	6.70E+01 +/- 5.22E+00	
30 JUN 87	02 JUN 87	1.24E+02 +/- 6.00E+00	
28 JUL 87	30 JUN 87	1.31E+02 +/- 6.22E+00	

Fraction of Results > 1.75 / 75 Mean: 1.65E+02
 Minimum: 3.93E+01 (22 NOV 83) Standard Error of Mean: 1.65E+01
 Maximum: 6.69E+02 (19 FEB 82) Standard Deviation: 1.60E+02
 Median: 1.51E+02

29-OCT-87

Version 1.0
ENVIRONMENTAL SAMPLE ANALYSIS RESULT RPT

Page 5

9413218.0652

09 JAN 82 to 28 JUL 87

Comments

- (1) THE SAMPLE 12/18/84 - 12/26/84 WAS INADVERTANTLY OMI FROM THE DECEMBER COMPOSITE.
- (2) SAMPLES WERE NOT COLLECTED 12/28, 1/4, AND 1/18. TH ONLY ENOUGH WATER TO RUN ALPHA, BETA, U, AND ENRICHE THE COMPOSITE 12/28/82 - 1/18/83.
- (3) SAMPLE TAKEN 12/18/84 - 12/26/84 WAS INADVERTANTLY O FROM THE DECEMBER COMPOSITE.
- (4) GRAB SAMPLE SUBSTITUTED.

1. NAME
 2. ADDRESS
 3. CITY
 4. STATE
 5. ZIP
 6. PHONE
 7. TELETYPE
 8. TELEFAX
 9. TELEMAIL
 10. TELEFAX
 11. TELEMAIL
 12. TELEFAX
 13. TELEMAIL
 14. TELEFAX
 15. TELEMAIL
 16. TELEFAX
 17. TELEMAIL
 18. TELEFAX
 19. TELEMAIL
 20. TELEFAX
 21. TELEMAIL
 22. TELEFAX
 23. TELEMAIL
 24. TELEFAX
 25. TELEMAIL
 26. TELEFAX
 27. TELEMAIL
 28. TELEFAX
 29. TELEMAIL
 30. TELEFAX
 31. TELEMAIL
 32. TELEFAX
 33. TELEMAIL
 34. TELEFAX
 35. TELEMAIL
 36. TELEFAX
 37. TELEMAIL
 38. TELEFAX
 39. TELEMAIL
 40. TELEFAX
 41. TELEMAIL
 42. TELEFAX
 43. TELEMAIL
 44. TELEFAX
 45. TELEMAIL
 46. TELEFAX
 47. TELEMAIL
 48. TELEFAX
 49. TELEMAIL
 50. TELEFAX
 51. TELEMAIL
 52. TELEFAX
 53. TELEMAIL
 54. TELEFAX
 55. TELEMAIL
 56. TELEFAX
 57. TELEMAIL
 58. TELEFAX
 59. TELEMAIL
 60. TELEFAX
 61. TELEMAIL
 62. TELEFAX
 63. TELEMAIL
 64. TELEFAX
 65. TELEMAIL
 66. TELEFAX
 67. TELEMAIL
 68. TELEFAX
 69. TELEMAIL
 70. TELEFAX
 71. TELEMAIL
 72. TELEFAX
 73. TELEMAIL
 74. TELEFAX
 75. TELEMAIL
 76. TELEFAX
 77. TELEMAIL
 78. TELEFAX
 79. TELEMAIL
 80. TELEFAX
 81. TELEMAIL
 82. TELEFAX
 83. TELEMAIL
 84. TELEFAX
 85. TELEMAIL
 86. TELEFAX
 87. TELEMAIL
 88. TELEFAX
 89. TELEMAIL
 90. TELEFAX
 91. TELEMAIL
 92. TELEFAX
 93. TELEMAIL
 94. TELEFAX
 95. TELEMAIL
 96. TELEFAX
 97. TELEMAIL
 98. TELEFAX
 99. TELEMAIL
 100. TELEFAX

...

An Assessment of Aquifer Intercommunication in the B Pond-Gable Mountain Pond Area of the Hanford Site

Date Published March 1984

Michael J. Graham
George V. Last
Karl R. Fecht
Rockwell Hanford Operations

Prepared for the U.S. Department of Energy
under Contract DE-AC06-77RL01030



Rockwell International

Rockwell Hanford Operations
Energy Systems Group
P.O. Box 800
Richland, Washington 99352

1.0 INTRODUCTION

In 1943, the Manhattan District of the U.S. Army Corps of Engineers chose an unpopulated semiarid region of the Pasco Basin in Washington State as the location for the Hanford Engineering Works. The site (Figure 1) was selected because of the need to isolate the first nuclear plants for national security reasons and to have a large area for isolating nuclear wastes from the public. Today, the Hanford Site is a U.S. Department of Energy (DOE) facility, and Rockwell Hanford Operations (Rockwell), a prime contractor to DOE, is responsible for nuclear waste management at Hanford.

Nuclear waste management at Hanford includes disposing of large volumes of liquid wastes to the ground (via ditches, ponds and underground cribs) and storing highly radioactive solutions in large underground steel lined reinforced concrete tanks. The waste management (disposal and storage) facilities are located near the chemical processing facilities in the Separations Area near the center of the Hanford Site. Normally, the radionuclide concentrations of the waste discharged to the ground average below maximum permissible concentration guidelines; however, occasional, nonroutine, releases of higher concentrations have occurred. As a result of these disposal practices, the unconfined aquifer underlying the Hanford Site has become contaminated (below applicable guidelines) and the water table has increased in elevation.

There is a series of confined aquifers in the interflow zones and interbeds between the dense basalt flows that underlie the sediments containing the unconfined aquifer. When postglacial flood waters and the ancestral Columbia River flowed between Gable Mountain and Gable Butte (Figure 1), portions of the basalt flows separating the unconfined and confined aquifers were eroded. Later the water table rose to levels exceeding the potentiometric surface of the upper confined aquifer, i.e., the Rattlesnake Ridge aquifer. This action created the driving force for the transport of contamination downward to the Rattlesnake Ridge aquifer through these areas of erosion, a phenomenon known as aquifer intercommunication.

REFERENCE 32

Memo to file from WS Weygandt regarding Personal
Conversation with Frank Trent concerning TUC Irrigation
Intake, August 12, 1987; including note to file from
RD Stenner on October 29, 1987, concerning Crops Grown
on the TUC 160 Acres

File Note

Date: 10/29/87

From: RD Stenner

RD Stenner

Subject: Crops Grown on the TUC 160 Acres

The 160 Acres that are irrigated by the Tri-Cities University Center are used to grow alfalfa which is used as cattle feed.

697-872-16



INSERT WLU-8-2
Project Number _____

Internal Distribution

File/LB

Date August 12, 1987
To File
From W. S. Weygandt *W. S. Weygandt*
Subject Tri-Cities University Center Water Intake

A telephone conversation with Frank Trent, the ground's manager at TUC, revealed that TUC draws water from the Columbia River to irrigate approximately 160 acres. The intake is located directly behind the Center, which is located on Sprout Road.

WSW:cs

REFERENCE 33

Memo to file regarding recreational use of the
Columbia River from DR Sherwood, August 26, 1987

690826
16



Battelle

Pacific Northwest Laboratories

Project Number _____

Internal Distribution

KH Cramer
RD Stenner
File/LB

Date August 26, 1987
To IWSS Files
From DR Sherwood *DRS*
Subject Recreational Use of Hanford Reach

The Hanford Reach of the Columbia River has many recreational uses. Sportsman's access for fishing and waterfowl, big game, and upland bird hunting is provided at several locations. Access points to the Columbia River along the Hanford Reach are located at the old White Bluffs Ferry landing, the Ringold Hatchery, and Leslie Grove Park in Richland. I have fished for steelhead and salmon along the Hanford Reach since 1980.

DRS/mgs

REFERENCE 34

Battelle Farm Operations Drawing, RC-486 and RC-1147

1997012616
943218166

File Note

Date: 10/29/87

From: RD Stenner *RD Stenner*

Subject: Telephone Conversation with Dale Schielke (PNL) Regarding
Battelle Farm Operations Agerage

The Battelle Farm Operations cover a total of 168.1 acres which are used for growing forage (food crops). The individual plot acrages are as follows:

62.5 acres

27.2 acres

20.6 acres

22.4 acres

5.7 acres

6.0 acres

14.0 acres

9.7 acres

168.1 acres total

297-0-062
91328-062

[illegible]

Page 44144	Serial 44144	Date 10/10/1964	Time 10:00	Location 1001	Remarks 1001
44145	44145	10/10/1964	10:00	1002	1002
44146	44146	10/10/1964	10:00	1003	1003
44147	44147	10/10/1964	10:00	1004	1004
44148	44148	10/10/1964	10:00	1005	1005
44149	44149	10/10/1964	10:00	1006	1006
44150	44150	10/10/1964	10:00	1007	1007
44151	44151	10/10/1964	10:00	1008	1008
44152	44152	10/10/1964	10:00	1009	1009
44153	44153	10/10/1964	10:00	1010	1010
44154	44154	10/10/1964	10:00	1011	1011
44155	44155	10/10/1964	10:00	1012	1012
44156	44156	10/10/1964	10:00	1013	1013
44157	44157	10/10/1964	10:00	1014	1014
44158	44158	10/10/1964	10:00	1015	1015
44159	44159	10/10/1964	10:00	1016	1016
44160	44160	10/10/1964	10:00	1017	1017
44161	44161	10/10/1964	10:00	1018	1018
44162	44162	10/10/1964	10:00	1019	1019
44163	44163	10/10/1964	10:00	1020	1020
44164	44164	10/10/1964	10:00	1021	1021
44165	44165	10/10/1964	10:00	1022	1022
44166	44166	10/10/1964	10:00	1023	1023
44167	44167	10/10/1964	10:00	1024	1024
44168	44168	10/10/1964	10:00	1025	1025
44169	44169	10/10/1964	10:00	1026	1026
44170	44170	10/10/1964	10:00	1027	1027
44171	44171	10/10/1964	10:00	1028	1028
44172	44172	10/10/1964	10:00	1029	1029
44173	44173	10/10/1964	10:00	1030	1030
44174	44174	10/10/1964	10:00	1031	1031
44175	44175	10/10/1964	10:00	1032	1032
44176	44176	10/10/1964	10:00	1033	1033
44177	44177	10/10/1964	10:00	1034	1034
44178	44178	10/10/1964	10:00	1035	1035
44179	44179	10/10/1964	10:00	1036	1036
44180	44180	10/10/1964	10:00	1037	1037
44181	44181	10/10/1964	10:00	1038	1038
44182	44182	10/10/1964	10:00	1039	1039
44183	44183	10/10/1964	10:00	1040	1040
44184	44184	10/10/1964	10:00	1041	1041
44185	44185	10/10/1964	10:00	1042	1042
44186	44186	10/10/1964	10:00	1043	1043
44187	44187	10/10/1964	10:00	1044	1044
44188	44188	10/10/1964	10:00	1045	1045
44189	44189	10/10/1964	10:00	1046	1046
44190	44190	10/10/1964	10:00	1047	1047
44191	44191	10/10/1964	10:00	1048	1048
44192	44192	10/10/1964	10:00	1049	1049
44193	44193	10/10/1964	10:00	1050	1050
44194	44194	10/10/1964	10:00	1051	1051
44195	44195	10/10/1964	10:00	1052	1052
44196	44196	10/10/1964	10:00	1053	1053
44197	44197	10/10/1964	10:00	1054	1054
44198	44198	10/10/1964	10:00	1055	1055
44199	44199	10/10/1964	10:00	1056	1056
44200	44200	10/10/1964	10:00	1057	1057

-R.C. 486

**FARM
OPERATION**

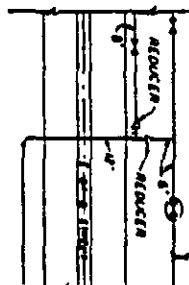
5-51-50

NOTE

LEGEND

ALL INFORMATION CONTAINED
HEREIN IS UNCLASSIFIED
DATE 08-07-2009 BY 60322
PAG 1

DETAIL A

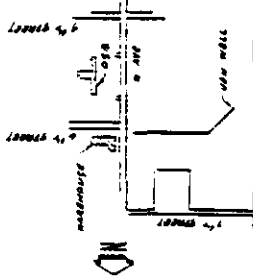


GENERAL NOTES

1. ALL WORK TO BE DONE WITHIN THE PROJECT AREA OF THE CITY OF CHICAGO.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
7. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.

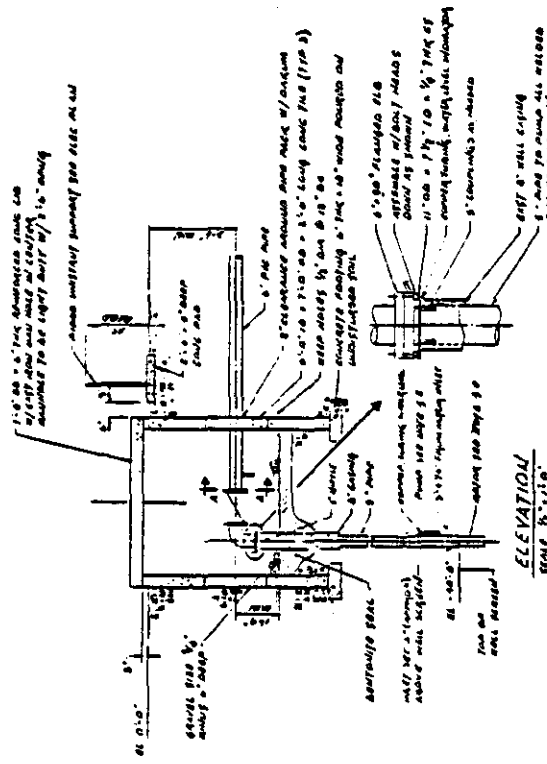
ELECTRICAL NOTES

1. ALL ELECTRICAL WORK TO BE DONE IN ACCORDANCE WITH THE 1997 NATIONAL ELECTRICAL CODE.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
7. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF CHICAGO.

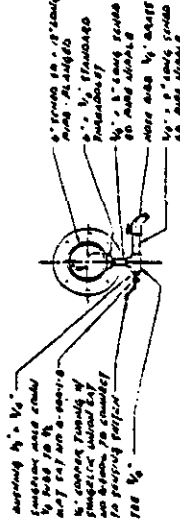


VICINITY PLAN
SCALE: 1" = 100'

NO.	DESCRIPTION	DATE	BY	CHECKED	APPROVED
1	CONSTRUCTION OF GROUND WATER WELL	10/1/00	JGP		
2	INSTALLATION OF ELECTRICAL SYSTEM	10/1/00	JGP		
3	INSTALLATION OF GROUND WATER WELL	10/1/00	JGP		
4	INSTALLATION OF ELECTRICAL SYSTEM	10/1/00	JGP		
5	INSTALLATION OF GROUND WATER WELL	10/1/00	JGP		
6	INSTALLATION OF ELECTRICAL SYSTEM	10/1/00	JGP		
7	INSTALLATION OF GROUND WATER WELL	10/1/00	JGP		
8	INSTALLATION OF ELECTRICAL SYSTEM	10/1/00	JGP		
9	INSTALLATION OF GROUND WATER WELL	10/1/00	JGP		
10	INSTALLATION OF ELECTRICAL SYSTEM	10/1/00	JGP		

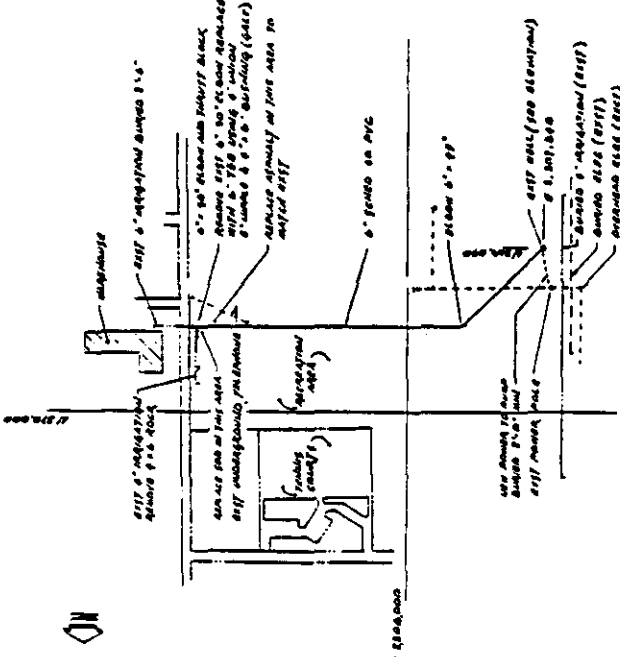


ELEVATION
SCALE: 1" = 10'

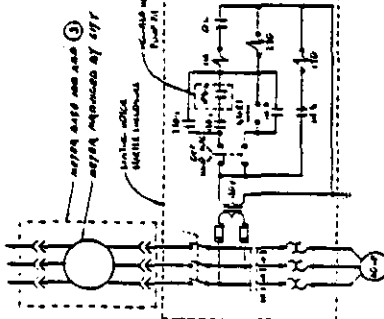


SECTION A-A
SCALE: 1" = 10'

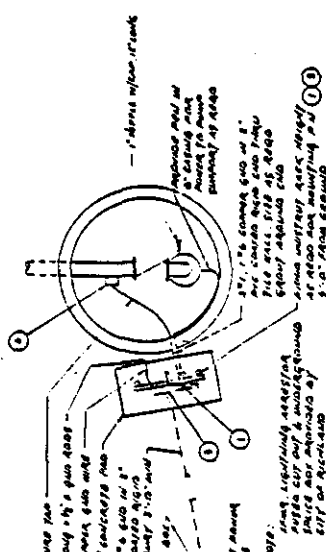
NO.	DESCRIPTION	DATE	BY	CHECKED	APPROVED
1	CONSTRUCTION OF GROUND WATER WELL	10/1/00	JGP		
2	INSTALLATION OF ELECTRICAL SYSTEM	10/1/00	JGP		
3	INSTALLATION OF GROUND WATER WELL	10/1/00	JGP		
4	INSTALLATION OF ELECTRICAL SYSTEM	10/1/00	JGP		
5	INSTALLATION OF GROUND WATER WELL	10/1/00	JGP		
6	INSTALLATION OF ELECTRICAL SYSTEM	10/1/00	JGP		
7	INSTALLATION OF GROUND WATER WELL	10/1/00	JGP		
8	INSTALLATION OF ELECTRICAL SYSTEM	10/1/00	JGP		
9	INSTALLATION OF GROUND WATER WELL	10/1/00	JGP		
10	INSTALLATION OF ELECTRICAL SYSTEM	10/1/00	JGP		



SITE PLAN
SCALE: 1" = 10'



ONE LINE DIAGRAM
SCALE: 1" = 10'



ELECTRICAL PLAN
SCALE: 1" = 10'

REFERENCE 35

Data Compilation: Iodine-129 in Hanford Groundwater, WHC-EP-0037

597-0126-6

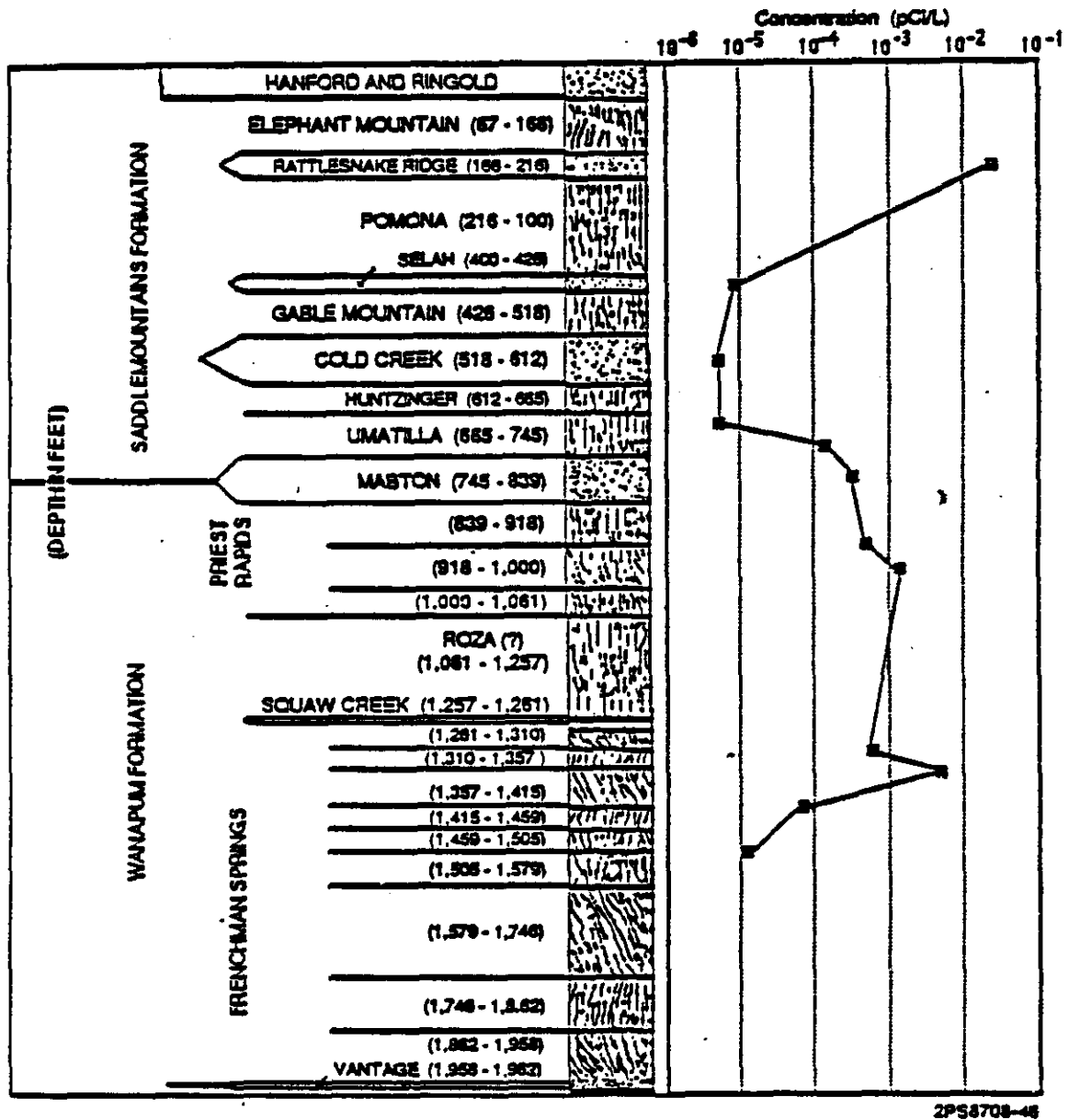


Figure 5-2. Depth Distribution of Iodine-129 in Relation to Relation to DB-15 Stratigraphy.

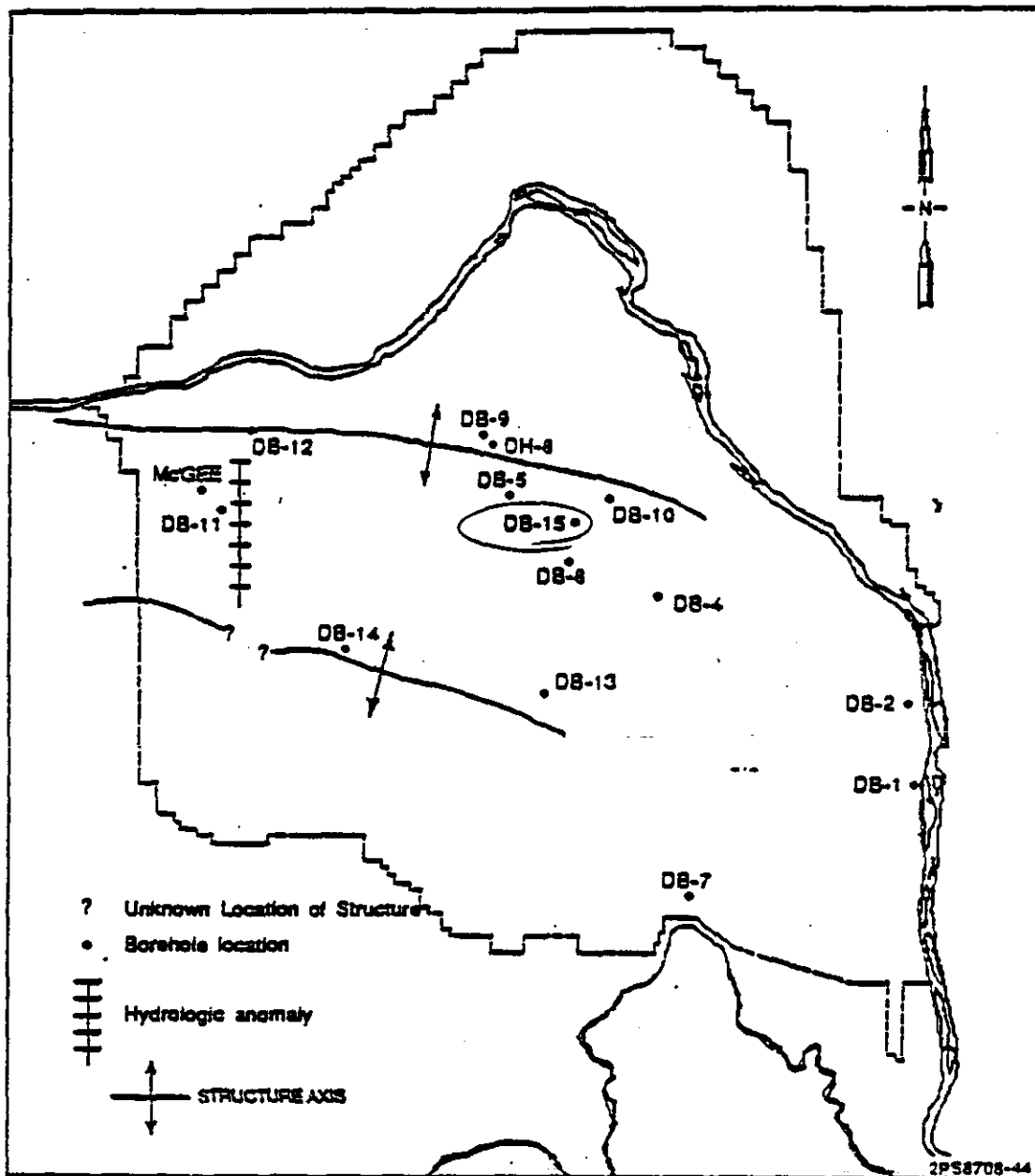


Figure 3-4. Location of "DB" Series Wells.

9413218.0668

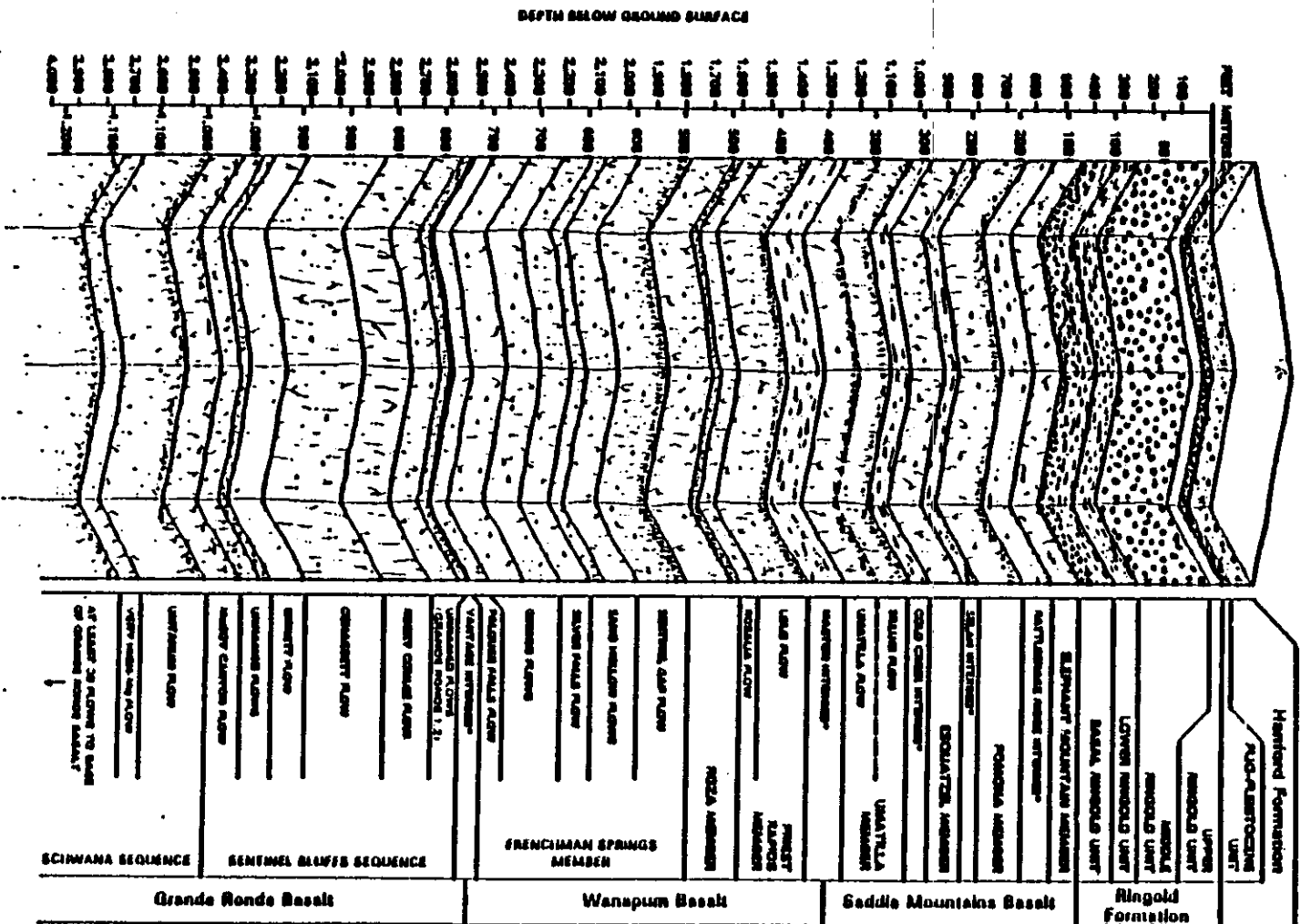


Figure 3-2. Generalized Stratigraphy of the Hanford Site.

REFERENCE 36

**Letter From RD Stenner to DM Bennett Regarding Ground Water Contaminant
Plumes in the 100 Area, 200 Area and 300 Area, October 14, 1987**

Note: Only the 200 Area attachments are included in this package



Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington U.S.A. 99352
Telephone (509)

Telex 15-2874

October 14, 1987

Mr. D. M. Bennett
U.S. Environmental Protection Agency
Region X
Superfund Program
1200 6th Avenue
Seattle, WA 98101

Dear Dave:

Enclosed are the three descriptions of the 100 Area, 200 Area and 300 Area ground water contaminant plumes we discussed on the telephone yesterday. I have included some attached figures and maps to help show the independency of the detected ground water contamination in each of the three aggregate areas.

If there are any questions regarding the descriptions, please contact me at 509-375-2916.

Sincerely,

A handwritten signature in cursive script, appearing to read "R.D. Stenner".

R.D. Stenner, Sr. Research Engr.
Earth and Environmental Sciences Center
GEOSCIENCES DEPARTMENT

RDS:th

200 Area Ground Water Contamination

The ground water tritium plume from the 200 Area is a discrete plume determined as the result of several years of ground water monitoring. The attached map shows the extent of the defined plume. As can be seen from the attached map there is considerable distance between the defined aggregate areas and their associated plumes. The seeps discussed as entry points for the contaminated plume to enter the surface water are within the defined plume and no upstream (upstream from the identified seeps) samples of the surface water indicate any influence on the tritium concentrations at the identified seeps. The 200 Area tritium plume enters the river between river mile 27 and river mile 33 as described in the document PNL-5289 (Reference 3).

6700246

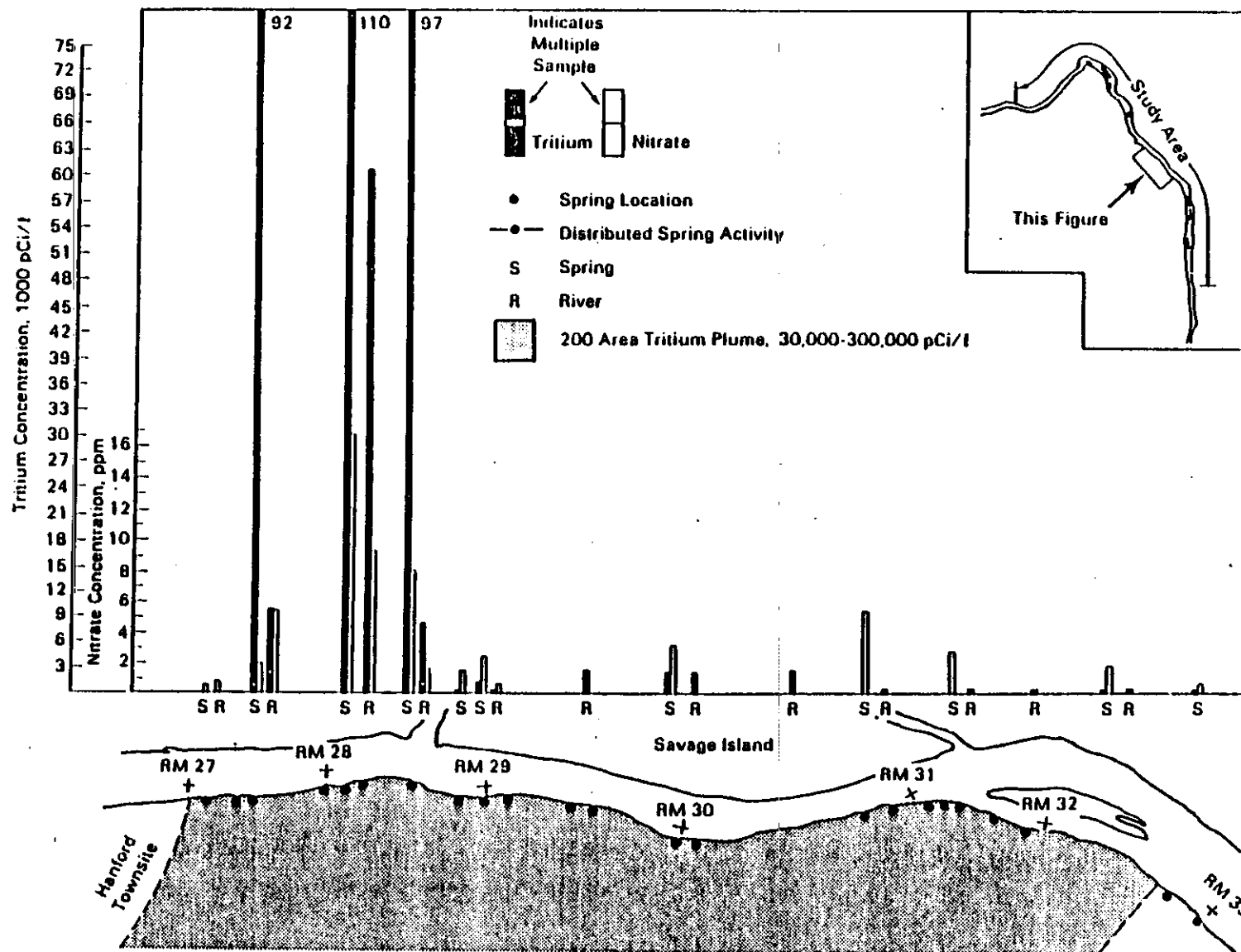
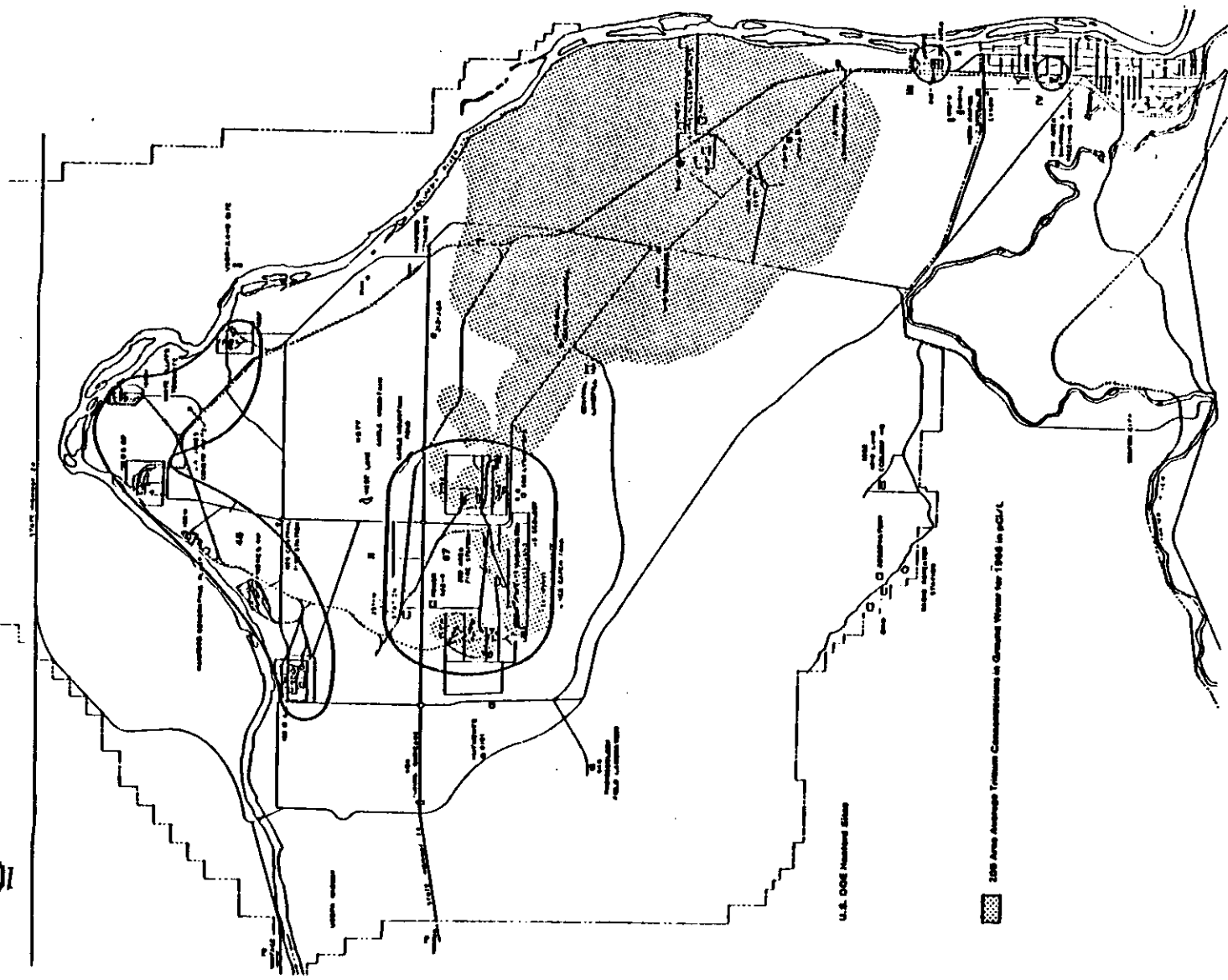


FIGURE 5. Locations and Analytical Results for Spring and River Samples - River Mile 27 through River Mile 33



REFERENCE 37

Letter From RD Stenner To DM Bennett Regarding Liquid Waste
Sites and Burning Pits, October 26, 1987

94-2200-1-1



Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington U.S.A. 99352
Telephone (509)

Telex 15-2874

October 26, 1987

D.M. Bennett
EPA/NPL Coordinator
EPA Superfund Program
U.S. Environmental Protection Agency Region X
1200 Sixth Ave.
Seattle, Washington 98101

Dear Dave:

Per your telephone request, enclosed are the statements on liquid waste sites and burning pits. It is our understanding that you will incorporate them as references in the appropriate sections of the NPL packages and provide us with a finalized copy of the packages following completion of the MITRE Corp. review.

If there are any questions regarding these statements, please don't hesitate to contact me at 509-375-2916.

Sincerely,

Bob

R.D. Stenner, Senior Research Engineer
Environmental Pathways and Assessment Section
Geosciences Department
Earth and Environmental Sciences Center

RDS:dar

ENCLOSURE

bcc: KH Cramer
MS Hanson
DA Lamar
RM Mangin - DOE/RL
TJ McLaughlin
RG Schreckhise
WB Schulze - DOE/RL
DR Sherwood

100, 200, 300 Area Statement Regarding Liquid Wastes

The general operating procedures for liquid waste sites in the 100, 200 and 300 Areas were such that the waste constituents listed for each site generally entered the process lines and were mixed with each other prior to being disposed of at the site. This process mixing of these waste constituents occurred over the period of site operation.

100, 200, 300
Area Statement
Regarding Liquid
Wastes

Burning Pit Statement

Due to the time period for which the burning pits operated, the nonhazardous combustible waste materials (i.e., paper products, cans, etc.) would have been mixed (i.e., mixed together in the garbage truck or waste container) with the hazardous waste materials (i.e., paints, solvents, etc.) prior to the waste mixture being disposed of at the site.

107-0176-1

REFERENCE 38

File note from RD Stenner to file on December 2, 1987
regarding Landfill Operations



MEMORANDUM

DATE: 12/18/87

FROM: R.D. Stenner *R.D. Stenner*

RE: Addendum to December 2, 1987 Letter Regarding Historic
Landfill Operations

The units associated with the December 2, 1987 letter on historic
landfill operation assumptions are as follows:

Horn Rapids Landfill (300 Area)
618-10 (200 Area)
618-11 (200 Area)
213-J&K (200 Area)
Central Landfill (200 Area)

9413218.000
0000000000

REFERENCE 39

Environmental Monitoring at Hanford for 1985

100-000000

Environmental Monitoring at Hanford for 1985

K. R. Price, Editor

May 1986

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute**



SURFACE-WATER MONITORING

The Columbia River constituted the primary environmental exposure pathway to the public for radioactivity in liquid effluents. Radionuclides in the river have decreased significantly since the shutdown of the plutonium production reactors with single-pass cooling systems and the installation of improved liquid effluent control systems at the N Reactor. However, radionuclides associated with Hanford operations continued to be routinely identified in the river water during 1985.

In addition to the river, four onsite ponds were sampled periodically to determine radionuclide concentrations. These ponds were accessible to migratory water fowl as well as other animals residing on the Site. As a result, a potential biological pathway existed for the removal and dispersal of any contaminants that may have been present in the pond water and sediments.

COLUMBIA RIVER

The Columbia River is used as a source of drinking water onsite as well as at communities downstream of the Hanford Site. As a result, the Environmental Protection Agency and the State of Washington drinking-water regulations are applicable (Appendix C). In addition, the river is also used extensively for crop irrigation and recreational activities such as fishing, hunting, boating, water skiing, and swimming. In view of this, the river water continued to be closely monitored for radionuclides of potential Hanford origin. Samples taken upstream and downstream of the Site are analyzed for selected radionuclides at frequencies commensurate with their half-lives and their importance as either verifiers of waste containment or indicators of potential environmental impacts. Radionuclides of primary significance in the river are ^3H , ^{60}Co , ^{89}Sr , ^{90}Sr , ^{131}I , ^{129}I , ^{137}Cs , $^{239,240}\text{Pu}$, and uranium (U).

Sample Collection and Analysis

Samples of Columbia River water were collected throughout 1985 at the upstream and downstream locations shown in Figure 23. The upstream sampler was located approximately mid-stream within Priest Rapids Dam and collected samples as water passed through the dam. Priest Rapids Dam is located approximately 5 miles upstream of the Hanford Site boundary. The downstream samples were collected at the 300 Area and City of Richland water-supply intakes. The 300 Area sampling location was near the southern boundary of the Site and collected water from the intake forebay along

the shoreline. The Richland sampler, located about 2 miles downstream of the site boundary, collected water from a point approximately 30 feet into the river from the shoreline.

Two types of samplers were used in most instances: a cumulative system that collected a fixed volume of water at set intervals during each sample period and a specially designed system that continuously collected waterborne radionuclides from the river water on a series of filters and ion-exchange resins. Grab samples were used in a few special cases when routine equipment was inoperable.

The cumulative samplers consisted of a timer-activated solenoid valve that periodically diverted a continuously flowing substream of Columbia River water into a 10 ℓ container. This cycle repeated itself throughout the 1-week sample period such that approximately 30 mL of water were collected every 30 minutes. The 10- ℓ sample container was changed every week, and the sample was taken to the laboratory, where the water from a single location was composited over a 4-week period prior to analysis, resulting in a total sample size of approximately 40 ℓ . Tritium, ^{89}Sr , ^{90}Sr and uranium were the radionuclides of interest in the samples collected with the cumulative sampling system.

A special system was used to separate the radionuclides from river water prior to analysis. A large volume of water was required to allow the extremely small concentrations of certain radionuclides in the river water to be detected.

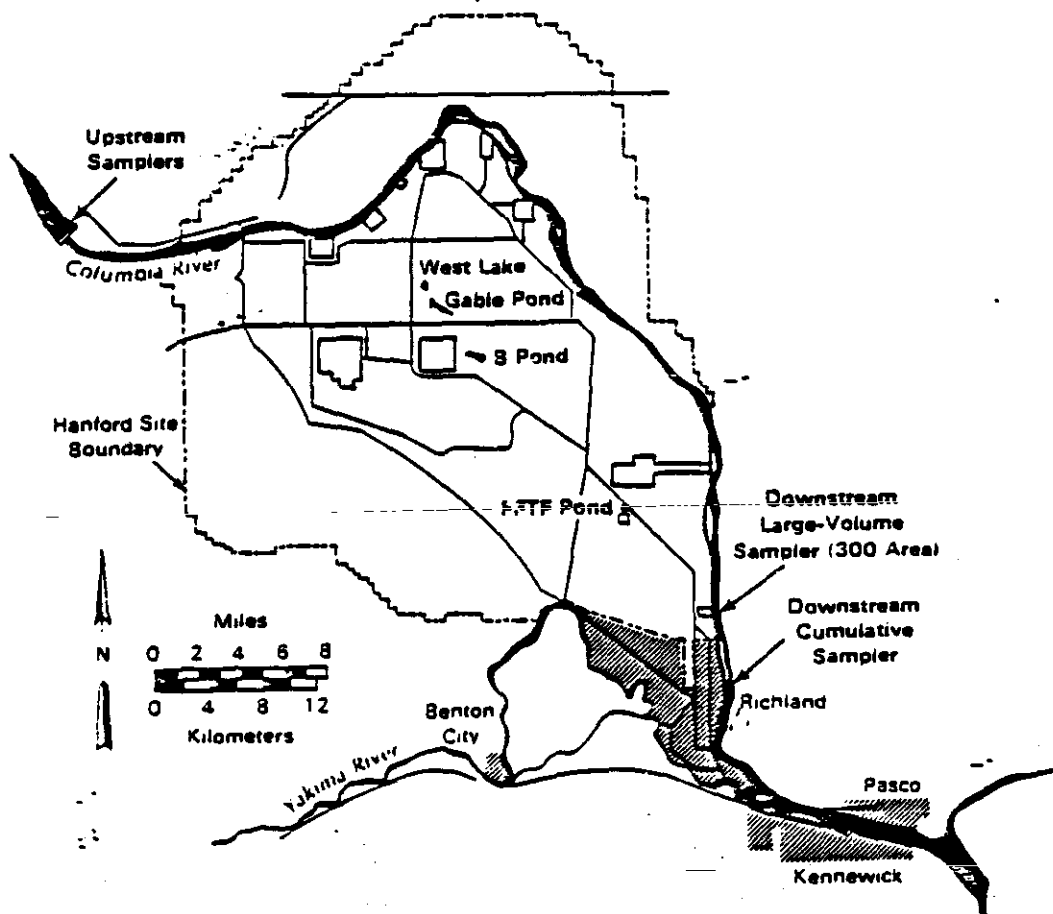


FIGURE 23. Columbia River Water Sampling and Onsite Pond Locations

River water flowed through the collection system at a rate of approximately 50 mL/min, resulting in a total volume of about 1000 l sampled during each 2-week sample period. Suspended particulates greater than 0.45 μ m in diameter were removed from the water on a series of filters, and soluble radionuclides, except tritium, were collected on a mixed-bed, ion-exchange resin column. The filters and ion-exchange resin were exchanged every 2 weeks and analyzed for gamma-emitting radionuclides. The filters and resin from each location were then composited separately for quarterly analyses of ^{129}I , ^{238}Pu , and $^{239,240}\text{Pu}$.

Results

The results of the analysis of Columbia River water samples collected during 1985 are summarized in Tables A.13 and A.14, Appendix A. Significant results are discussed and illustrated below, with comparisons to previous years' results provided as well. Radionuclides consistently observed in measurable quantities in river water during 1985 were ^3H , ^{90}Sr , U , ^{129}I , ^{137}Cs , and $^{239,240}\text{Pu}$. All of these are reportedly present in effluents from Hanford facilities and exist in worldwide fallout as well. In addition, ^3H and U occur naturally in the environment.

Annual average concentrations of tritium measured upstream and downstream of the Hanford

Site during 1985 were 110 pCi/l and 150 pCi/l, respectively. Figure 24 provides a comparison of monthly tritium concentrations observed in river water, showing that concentrations downstream were generally higher than those upstream during the year. Statistical tests indicated that the difference between the downstream and upstream concentrations was significant.^(a) Sources of tritium entering the river were effluent releases from N Reactor and ground water entering the river along the Site (see "Effluents, Waste Disposal, and Unusual Occurrences" and "Ground-Water Monitoring"). The concentrations of tritium observed in the river during 1985 were similar to those observed during recent years and were comparable to measurements made on Columbia River water by State of Washington personnel (DSHS 1985). Figure 25 provides a comparison of the annual average concentrations of ^3H , ^{90}Sr , and U for the period

1981 through 1985. All observed tritium concentrations were well below the State of Washington and EPA screening level of 20,000 pCi/l for drinking water.

The ^{90}Sr concentrations measured upstream and downstream during 1985 were essentially the same (0.15 pCi/l and 0.16 pCi/l, respectively). Figure 25 shows the annual average ^{90}Sr concentration to be slightly higher at the downstream location, consistent with observations made in past years. However, differences observed since 1981 have been very slight, especially when the uncertainty associated with the averages is considered. Figure 26 presents the monthly ^{90}Sr concentrations observed during the year at both the upstream and downstream locations, demonstrating that downstream concentrations are not consistently higher than the upstream concentrations. Statistical tests also indicated that the difference between upstream

(a) Paired sample comparison, t-test of differences (Snedecor and Cochran 1976).

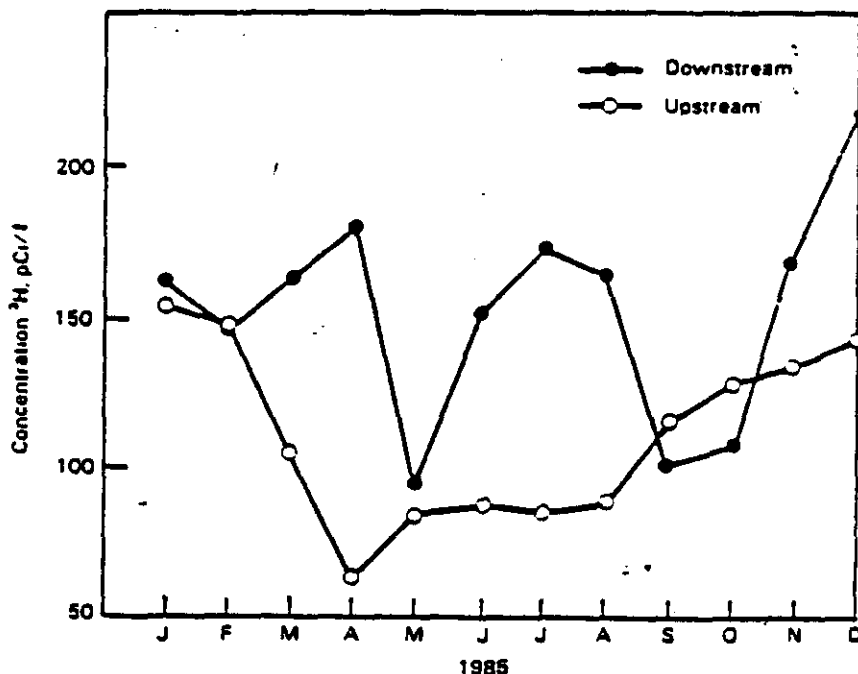


FIGURE 24. Tritium Concentrations Measured in Columbia River Water During 1985

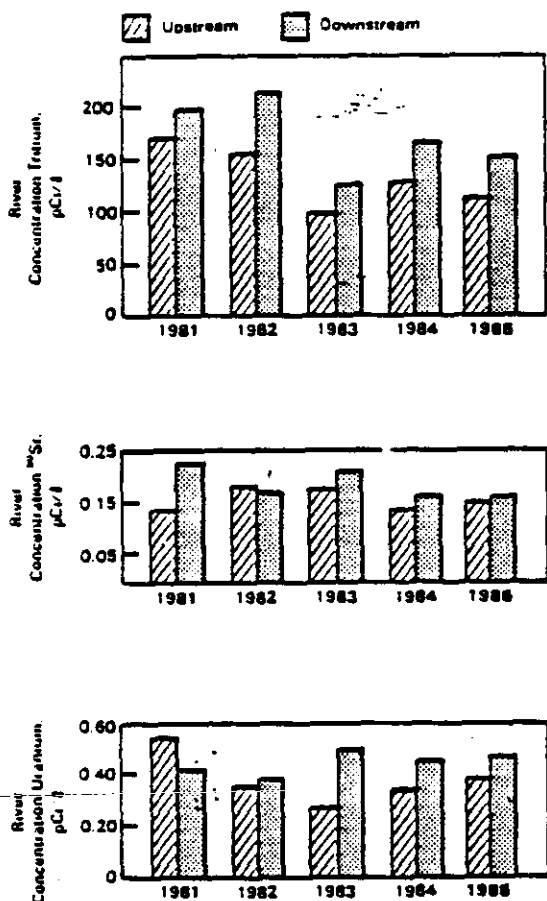


FIGURE 25. Annual Average Tritium, Strontium-90 and Uranium Concentrations Measured in the Columbia River, 1981 to 1985

and downstream concentrations was insignificant. The only known source of ^{90}Sr entering the Columbia River was from the 100N liquid-waste disposal facility, which reportedly discharged 8.7 Ci to the river during 1985. All ^{90}Sr concentrations observed during 1985 in the Columbia River water were well below the State of Washington and EPA screening level of 8 pCi/l for drinking water.

Strontium-89 concentrations in Columbia River water collected upstream and downstream of Hanford were generally below the detection level during 1985. As in past years, average concentrations of ^{89}Sr were essentially the same upstream and downstream of the Site (0.087 pCi/l and 0.100 pCi/l, respectively).

Uranium concentrations in 1985 continued to be slightly higher in samples of Columbia River water collected downstream of Hanford than in those collected upstream, as shown in Figure 25. While the difference in the annual averages upstream versus downstream (0.38 pCi/l and 0.48 pCi/l, respectively) is very slight, monthly values observed during the year were generally higher at the downstream location, as Figure 27 shows. All uranium concentrations observed during 1985 correspond with doses well below the State of Washington and EPA standard of 4 mrem/yr for drinking water. Although there is no direct discharge of uranium to the river, it is known to be a primary constituent of the ground water beneath the 300 Area (see "Ground-Water Monitoring" section) and has been detected at elevated levels in riverbank springs entering the river in this area (McCormack and Carlile 1984).

As in the past several years, ^{129}I concentrations continue to be higher in downstream river water than upstream. The average upstream and downstream concentrations in river water during 1985 were 9 aCi/l and 88 aCi/l, respectively. Iodine-129 in the river is attributable to the flow of ground water, which is known to contain ^{129}I , from the unconfined aquifer into the river (see "Ground-Water Monitoring" section). Figure 28 provides the quarterly ^{129}I results for the upstream and downstream locations and also shows the average quarterly flow rate of the Columbia River for 1985 and the previous 5 years. As the figure shows, the differences observed during 1985 between the upstream and downstream concentrations were similar to the differences observed in past years. The figure also illustrates the influence of the river flow rate on the downstream ^{129}I concentrations, as higher flow rates are associated with reduced concentrations, and vice versa. As has been the case for other radionuclides, the concentrations of ^{129}I observed in the Columbia River water during 1985 were well below those concentrations which would result in doses exceeding the State of Washington and EPA Standard for drinking water, 4 mrem/yr.

Reference 40

Memo from Kathleen Galloway, MITRE, to Sandy Crystall, EPA
December 29, 1987

1897-9126-4

MITRE

Reference 40

To: Sandy Crystall,
Acting Chief for NPL Operations,
Environmental Protection Agency (EPA)

Date: 29 December 1987

From: Kathleen Galloway, Member of the Technical Staff
The MITRE Corporation

Subject: The Toxicity of Uranium and Plutonium

Copies: B. Myers, S. Parrish

According to Sax, uranium is a highly toxic element on an acute basis as well as on a radio-toxic basis. For this reason the Agency feels it is appropriate to assign a value of 3 for the toxicity of uranium.

Sax states that the toxicity of plutonium compounds is based first upon the very high radio-toxicity of the plutonium atom. In addition, the permissible levels for plutonium are the lowest for any radioactive element. Therefore, although a method for assigning toxicity values for radio-nuclides is not established, the language in Sax would appear to justify a toxicity value of 3 for plutonium.

KG/js

The MITRE Corporation
Civil Systems Division
7525 Colshire Drive, McLean, Virginia 22102-3481
Telephone (703) 883-6000/Telex 248923

897-0726-16
94320-0600